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Habitat Relationships and Management of Terrestrial Birds in Northeastern Alberta

Project LS 2 2.1.1
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These research reports describe the results of investigations funded under the Alberta Oil Sands Environmental Research Program, which was established by agreement between the Governments of Alberta and Canada in February 1975 (amended September 1977). This 10-year program is designed to direct and co-ordinate research projects concerned with the environmental effects of development of the Athabasca Oil Sands in Alberta.

A list of research reports published to date is included at the end of this report.

Enquiries pertaining to the Canada-Alberta Agreement or other reports in the series should be directed to:

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Habitat Relationships and Management of Terrestrial Birds in Northeastern Alberta

Project LS 22.1.1

AOSERP Report 78

This report may be cited as:

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The Hon. J.W. (Jack) Cookson
Minister of the Environment
222 Legislative Building
Edmonton, Alberta

and

The Hon. John Roberts
Minister of the Environment
Environment Canada
Ottawa, Ontario

Sirs:

Enclosed is the report "Habitat Relationships and Management of Terrestrial Birds in Northeastern Alberta".

This report was prepared for the Alberta Oil Sands Environmental Research Program, through its Land System, under the Canada-Alberta Agreement of February 1975 (amended September 1977).

Respectfully,

W. Solodzuk, P.Eng.
Chairman, Steering Committee, AOSERP
Deputy Minister, Alberta Environment

A.H. Macpherson, Ph.D
Member, Steering Committee, AOSERP
Regional Director-General
Environment Canada
Western and Northern Region

HABITAT RELATIONSHIPS AND MANAGEMENT OF TERRESTRIAL BIRDS IN NORTHEASTERN ALBERTA

DESCRIPTIVE SUMMARY

BACKGROUND

Boreal forests typically support an abundance of terrestrial non-gamebirds; 200 to 250 bird species breed in boreal forest habitats in Canada. As the Alberta Oil Sands Environmental Research Program (AOSERP) study area is situated within the boreal forest region, concern for the impact of oil sands development on terrestrial non-gamebirds was expressed early in the program planning.

The impact of industrial and/or recreational developments on terrestrial non-gamebirds has received minimal attention, therefore techniques and methodologies for assessing impact on this group of birds have been slow in developing. AOSERP contracted the Canadian Wildlife Service to develop census techniques whereby bird species densities, distributions, and habitat relationships could be delineated in the boreal forest habitats within the AOSERP study area.

ASSESSMENT

This report has been reviewed by scientists within Alberta Environment, the Canadian Wildlife Service, and external reviewers. The consensus has been that the authors are to be commended for the tremendous volume of data which was compiled and for innovative approaches taken in project design and data analysis. The data, however, do suffer from a lack of rigorous statistical treatment in that the level of interpretation could have been enhanced and the full potential of the data realized. The authors have recognized this deficiency and have suggested several approaches to rectify the problem; however, due to time and budgetary constraints, the additional benefits of these approaches in data analysis were deemed to be unjustified.

This report contributes significantly to the development of census techniques for terrestrial non-gamebirds in boreal forest habitats of Canada and provides AOSERP with useful management tools.

The Alberta Oil Sands Environmental Research Program accepts the report entitled "Habitat Relationships and Management of Terrestrial Birds in Northeastern Alberta" and recommends that it be published and given wide distribution.

William R McDonald

W. R. MacDonald
Director (1980-81)
Alberta Oil Sands Environmental
Research Program

HABITAT RELATIONSHIPS AND
MANAGEMENT OF TERRESTRIAL
BIRDS IN NORTHEASTERN ALBERTA

by

J. FRANCIS and K. LUMBIS
Canadian Wildlife Service

for

ALBERTA OIL SANDS ENVIRONMENTAL
RESEARCH PROGRAM

Project LS 22.1.1

September 1979

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ABSTRACT

Breeding bird studies using the mapping method were combined with intensive habitat quantification to determine the relative values to breeding avifauna of 21 habitat types. The large plot sizes allowed division of many plots into subplots, from which the value of certain habitat variations were induced. An annotated list of bird species was prepared, giving the status and phenology of all bird species observed in the study area. Suitable and preferred habitats are detailed for each bird species, as well as the population densities found in studied habitats. Potential impact of oil sands development is detailed, and recommendations as to how to minimize that impact are included. Guidelines for reclamation of developed areas are suggested.

ACKNOWLEDGEMENTS

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To Carol Boyle and Dirk Hadler of AOSERP, thank you for rendering remote field camps livable through your concern and support.

The many illustrative figures contained in the following pages exemplify the talent of Susan Popowich and Brian Chubb.

Finally we would like to thank So Sop Inn for the expert manner in which the final draft of this report was prepared.

This research project LS 22.1.1 was funded by the Alberta Oil Sands Environmental Research Program, a joint Alberta-Canada research program established to fund, direct, and co-ordinate environmental research in the Athabasca Oil Sands area of northeastern Alberta.

1. INTRODUCTION

This is the final report of avifauna project LS 22.1.1[1] to the Alberta Oil Sands Environmental Research Program (AOSERP). This final report outlines species densities, distributions, diversity and intensive habitat quantification, and has enabled detailed relationships between breeding birds and habitat to be discussed for terrestrial non-game and upland gamebirds. An annotated checklist of all bird species known to occur in the oil sands area is also included.

Previous reports on this project include an interim report submitted on 31 October 1976, in which the objectives and methodology employed in 1976 were discussed together with an outline of the program direction for 1977 and subsequent years. An annual progress report was submitted in April 1977, which provided: (1) short- and long-term objectives of the avifauna program; (2) a description of the AOSERP study area in terms of avifauna concerns; (3) details of the methodology employed; (4) a description of the habitats which were studied; (5) bird density estimates; and (6) interpretation of bird-habitat relationships. A draft final report was submitted in March 1978.

The primary objective of these baseline studies is to provide a complete description of the presence, distribution, and density of birds, along with the habitat requirements of each species or groups of species, as assessed through the correlation of census data with habitat quantification. The objective of this project was to ensure that an adequate data base would be available to assess and mitigate the potential impact of oil sands development on the avifauna resource and to present informed guidelines to the future direction that land reclamation should take (as it would apply to avifauna).

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[1] Avifauna studies have been organized in the following manner:

TF 2.1 - Waterfowl, upland gamebirds and passerines, 1976-1978.
TF 2.2 - Rare and sensitive species: White Pelicans, 1976-1978.
TF 2.3 - Rare, and sensitive species: Peregrine Falcon, Bald Eagle, Raptor, and colonial bird inventory, 1975-1978.
LS 22.0 - All AOSERP avifauna projects, 1978-1979.
    LS 22.1.1 - Upland game birds and passerines.
    LS 22.1.2 - Waterfowl.
    LS 22.2 - White Pelican, Volume I--Breeding, Volume II--Foraging
    LS 22.3.1 - Peregrine Falcon
    LS 22.3.2 - Raptor and colonial bird surveys.

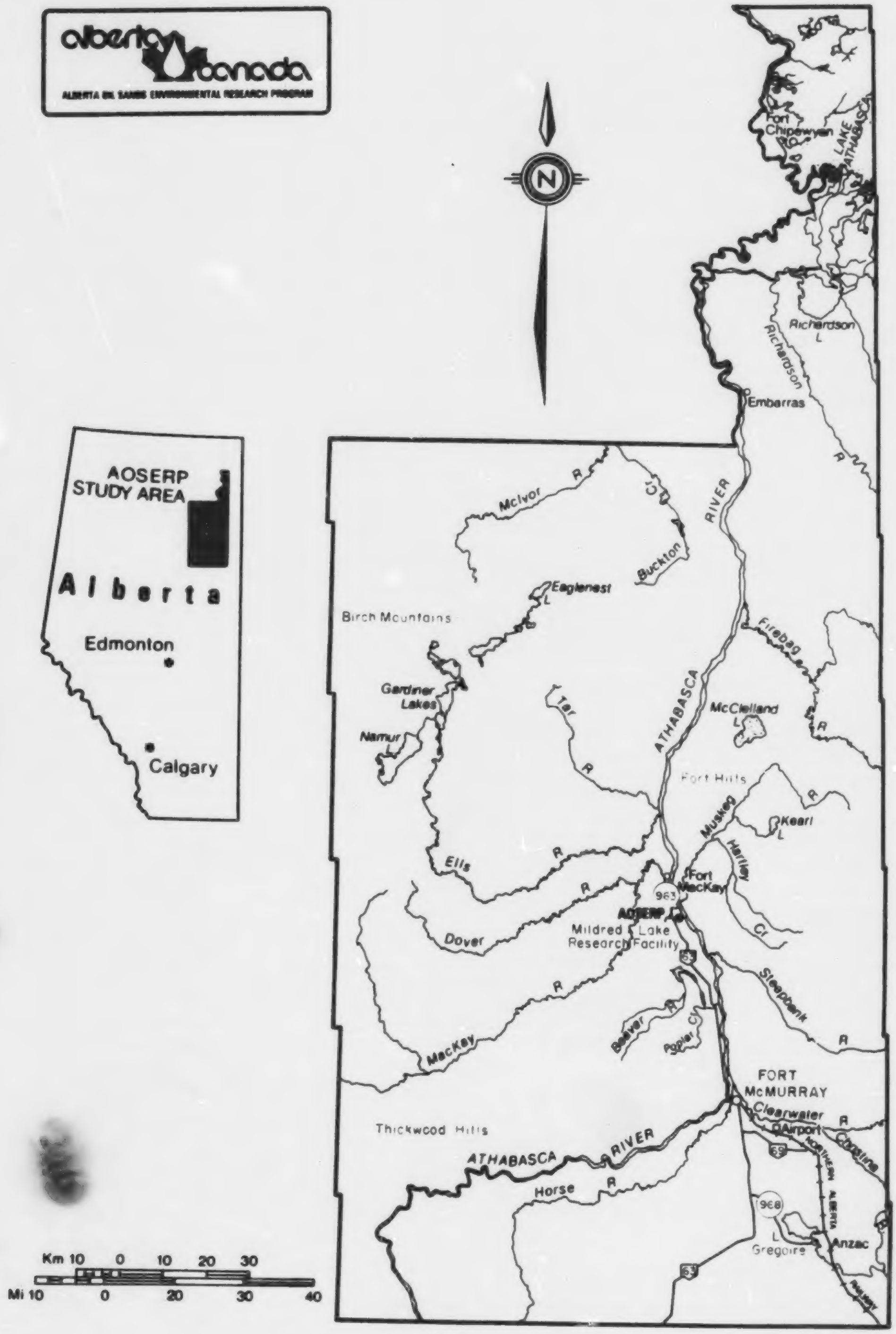
2. DESCRIPTION OF THE STUDY AREA

The following description is by no means comprehensive, but rather includes those features which may have an influence on avian populations in the oil sands area.

The AOSERP area (hereinafter called the oil sands) covers approximately 28 000 km^2, extending from 56°15' to 59°00' N Latitude and 110°47' to 112°55' W Longitude, excluding Wood Buffalo National Park (Figure 1). It incorporates most of the 23 000 km^2 of the area known as the Athabasca Oil Sands (Carrigy and Kramers 1974).

The general elevation of the area is roughly 275 to 450 m above sea level (asl). Rising above this platform of lacustrine and alluvial deposits are the Birch Mountains (Elev. 825 m asl) to the northwest, Stony Mountain (760 m asl) to the south, and Muskeg Mountain (640 m asl) to the east. The Thickwood and Fort hills (520 and 340 m asl) are located 20 km west and 70 km north of Fort McMurray, respectively. The Athabasca River, bearing from the southwest and turning north at Fort McMurray where it is joined by the Clearwater River from the east, has carved through the platform to an elevation of approximately 235 m asl. Between Grand Rapids, 90 km southwest of Fort McMurray, and Lake Athabasca, 220 km to the north, the Athabasca River drops 165 m. Along this reach, within the AOSERP study area, the Athabasca is fed by a number of tributaries including the Beaver, MacKay, Dover and Ells rivers from the west, and the Steepbank, Muskeg and Firebag rivers from the east.

A dense distribution of lakes (relative to other portions of the oil sands) occurs in the Birch Mountains (Namur and Gardiner being the largest at 44 km^2 and 54 km^2, respectively) and in the sand hills extending northeast from the Athabasca River 125 km north of Fort McMurray. Elsewhere, large lakes are widely distributed; the major ones include Ronald, McClelland, Algar, and Gregoire. Just beyond the study area, 55 km southeast of Fort McMurray, is Gordon Lake (115 km^2), worthy of mention here because of its significance as a migration stop for waterfowl.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Muskeg R
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Beaver R
Poplar Cr
MacKay R
FORT McMURRAY
Clearwater R
Airport
Christina
Thickwood Hills
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Figure 1. Location of the AOSERP study area.

Additionally, in the oil sands area, there is a scattered distribution of numerous small lakes of variable nature, from small muskeg-type beaver ponds to lakes with sand beaches.

The vegetation of the area has been described by LeRoi (1967). It includes portions of the regions known as the boreal-subarctic alluvial lowlands, the boreal subarctic jack pine sandplains, and the boreal mixedwood (Rowe 1959). Figure 2 illustrates the boreal forest zones of northeastern Alberta. A more detailed description of plant communities has been prepared by Stringer (1976) and a forest cover map at a scale of 1 inch = 2 miles has been published by the Alberta Department of Lands and Forests (1951). Although there are extensive monotypic vegetation communities, vegetation patterns generally are complex, including numerous combinations of species and age classes.

There is a general, but not restrictive, correlation of physiographic regions and vegetation communities within the study area, namely: (1) the upland mixed forest communities of the elevated areas (Birch Mountains, Thickwood and Fort hills); (2) the white spruce-balsam poplar-river alder-willow community of the Athabasca River valley; (3) the jack pine stands of the sand hills north and west of McClelland Lake; and (4) the variable composition muskeg communities over much of the remainder of the study area.

The following climatic and weather data have been extracted from Longley (1967). The study area lies in the cool temperate zone experiencing short cool summers. The mean January temperature is -20°C with an extreme low of -54°C. The mean July temperature is 15°C with an extreme high of 38°C. The average annual precipitation is 46 cm of which 30 cm fall as rain. Average annual snowfall is 152 cm. There is an average of 300 h of sunshine in July and 80 hours in January. The average frost-free period is 80 to 100 days.

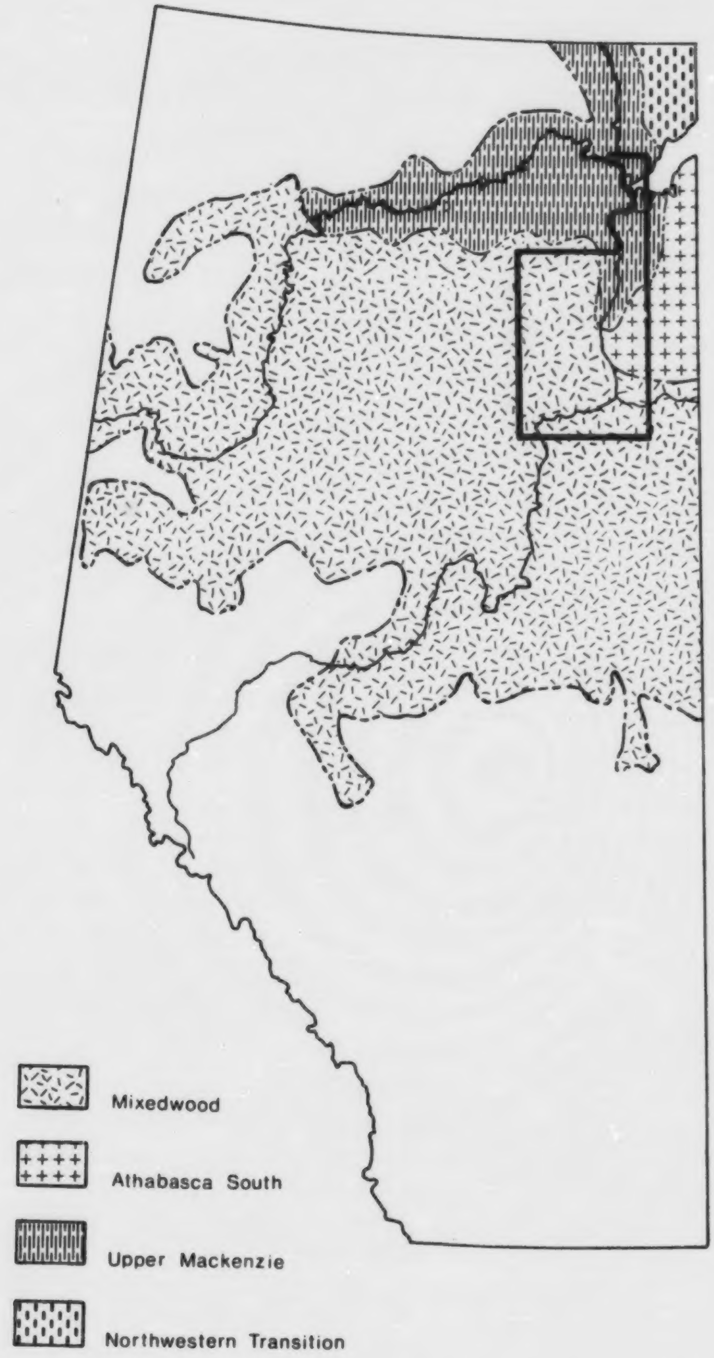
Mixedwood
Athabasca South
Upper Mackenzie
Northwestern Transition

Figure 2. Boreal forest zones of northeastern Alberta (Rowe 1972).

Approximate sunrise and sunset times at Fort McMurray are as follows (Mountain Standard Time):

	Sunrise	Sunset	Hrs. of Daylight
21 March	0624	1843	12.25
22 June	0332	2123	18
23 September	0608	1829	12.5
22 December	0901	1546	6.75

Predominant winds (generally light) at the Syncrude plant site are southeast during both winter and summer, but northerly winds occur more frequently in winter than in summer.

Fort McMurray, located in the valley at the confluence of the Athabasca and Clearwater rivers, is the only major urban center within the AOSERP study area. Established as a Hudson's Bay trading post in 1870, Fort McMurray grew very slowly and sporadically to a town of only 1200 in the early 1960's. Suddenly, with the onset of current oil sands activity, the population leaped to 8000 between 1965 and 1967 and more than doubled to 17 000 in the nine years since Great Canadian Oil Sands (GCOS)[1] began its operations (MacGregor 1974; B. Banas pers. comm. 1977). The only other communities in the area are Anzac, 39 km south of Fort McMurray, with a current population of 200, and Fort MacKay, 52 km north of Fort McMurray, with a population of 250 (population estimates: B. Banas pers. comm. 1977).

The GCOS and Syncrude-Bechtel operations supported staffs of approximately 1000 and 5000 to 7500, respectively, on site at any one time (Banas pers. comm. 1977). Thus, they are population centers in their own right.

Provincial Highway #63 connects Fort MacKay, the GCOS and Syncrude plants, and Fort McMurray to Edmonton 480 km to the southwest.

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[1] GCOS amalgamated with Sun Oil Company in August 1979, after the writing of this report was completed, to become Suncor, Inc.

3. UPLAND GAMEBIRDS

3.1 OBJECTIVES

Upland gamebird data were collected on summer and winter plots with the following objectives in mind:

1. To determine the abundance of breeding upland gamebird populations in various habitats; and
2. To assess the seasonal distribution of upland gamebird populations in selected habitats.

3.2 METHODS

3.2.1 Winter Upland Birds

Scope of the assessment, based largely on availability of funds and manpower, was limited to four surveys of each of four plots located in different habitat types (Figure 3). These habitats (jack pine forest, aspen forest, aspen-white spruce forest, and black spruce muskeg) were selected on the basis of their representativeness, accessibility, and occurrence in blocks extensive enough to accommodate a square kilometre census unit. The plots were laid out in January using a compass and a 50 m length of rope. Lines were 1 km long and 250 m apart, and marked at 50 m intervals with survey flagging. The habitat was described by the sampling of 50 m^2 blocks on either side of the lines. Descriptive parameters included topography, cover types, cover distribution, dominant species, and snow depth. The plots were surveyed, according to the King census method (Trippensee 1948), on 26 January to 2 February, 17 to 20 February, 10 to 13 March, and 23 to 26 March. Census data included a description of the site from which the birds were flushed (see census and habitat description forms, and field guides as to their use, Appendices 8.4 to 8.7).

3.2.2 Breeding Upland Birds (Summer)

During the census of each terrestrial breeding-bird plot, conducted during the summer, all grouse observations were plotted

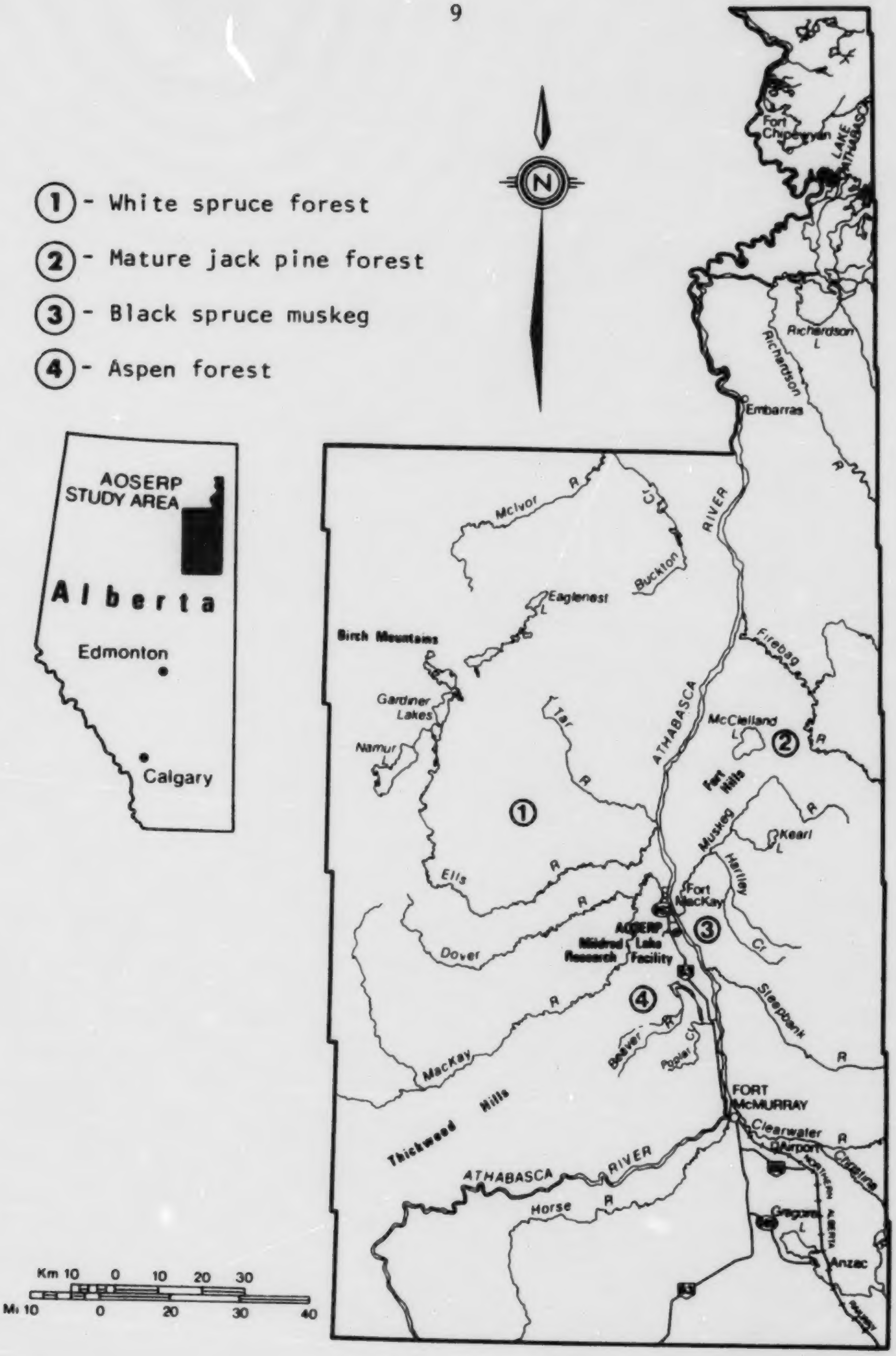
① - White spruce forest
② - Mature jack pine forest
③ - Black spruce muskeg
④ - Aspen forest
N
AOSERP STUDY AREA
Alberta
Edmonton
Calgary
Fort Chipewyan
LAKE ATHABASCA
Richardson L
Richardson R
Embarras
McIvor R
Buckton Cr
RIVER
Eaglenest L
Birch Mountains
Gardiner Lakes
Namur L
Firebag
ATHABASCA
McClelland L
Tar R
Fort Hills
Muskeg R
Kearl L
Hartley Cr
Ells R
Fort MacKay
AOSERP Mildred Lake Research Facility
Dover R
Steepbank R
Beaver R
Poplar Cr
MacKay R
Thickwood Hills
FORT McMURRAY
Clearwater R
Airport
Christina
ATHABASCA RIVER
Horse R
Gregoire L
NORTHERN ALBERTA
Anzac
Km 10 0 10 20 30
Mi 10 0 20 30 40

Figure 3. Location of plots surveyed for winter upland gamebirds.

on a daily grid map and subsequently were transferred to a species summary map. The summer terrestrial breeding-bird methodology is discussed in a later section. From the total number of observations on a plot and the total distance walked on the plot, the number of observations per kilometre was calculated for both Spruce and Ruffed Grouse on each plot. The average flushing distance, the distance from the transect line to the point where the grouse was first observed, was calculated for each of the above species. Drumming Ruffed Grouse were not included in this calculation. These data were collected between May and mid-July during 1976 and 1977.

3.3 RESULTS

3.3.1 Winter Upland Birds

Table 1 is a summary of the census data from all surveys of the plots. The greatest number of birds or flocks were recorded in jack pine and fewest in aspen/white spruce. The most common species observed were Spruce Grouse and Willow Ptarmigan. No Sharp-tailed Grouse were observed during the winter. The number of observations per kilometre walked in each habitat is presented in Table 2.

3.3.2 Breeding Upland Birds

Table 3 presents a summary of the number of grouse observations per kilometre walked on each terrestrial breeding bird plot. The highest Spruce Grouse density was recorded on the young mixed forest plot, the highest Ruffed Grouse density on the tall bottomland willow plot. Spruce Grouse bred on 10 of the 19 plots sampled while Ruffed Grouse bred on 8. Habitat descriptions of the terrestrial breeding bird plots are contained in a later section.

Table 4 presents a summary of the flushing distances for Spruce Grouse and Ruffed Grouse on the terrestrial breeding bird plots. The average flushing distance for 92 Spruce Grouse was 12.38 ± 9.15 [Standard Deviation (S.D.)] m while for 11 Ruffed Grouse it was 14.55 ± 11.25 (S.D.) m.

Table 1. Summary of Upland-bird Winter Census Data, Oil Sands Area, 1976.

Habitat Type	Location	Length of Census Strip (m)	Survey Date	Temp °C	Species[1]	Number	Flushing Distance (m)	Veg'n at Flushing Site[2]	Cover[3]	Snow Depth (m)	Snow Condition[4]
Aspen/White Spruce	10-97-12-W4	5000	26/01/76	-15	UG	1	17	PM/SA/AL	WA	0.4	O
			18/02/76	-20 to -10	NIL	--	--	--	--	--	--
			11/03/76	-12 to -04	UG	1	7	PT/PG	PT/PG	0.6	FO
			23/03/76	-05 to +02	NIL	--	--	--	--	--	--
Aspen/Shrub	1-95-9-W4	6000	NOT DONE IN		FIRST	SET	OF	SURVEYS			
			17/02/76	-15 to -10	NIL	--	--	--	--	--	--
			12/03/76	-09 to -04	NIL	--	--	--	--	--	--
			25/03/76	-06 to +02	PT	1	4	SA/PT	PT	0.4	C
					RG	1♂	8	SA/PT	PT	0.4	C
					UG	1	5	PG/PT	PG/PT	0.4	C
Jack Pine	6-48-1-W4	6000	02/02/76	-28 to -22	UG	1	12	JP	JP	0.3	WO
					UG	1	6	JP	JP	--	WO
					SG	1	3	JP	JP	0.3	WO
					SG	1♂	8	JP	JP	0.3	WO
			20/02/76	-15 to -08	SG	1	20	AL/JP	JP	0.3	O
					SG	1	4	AL/JP	JP	0.3	O
					SG	1	9	AL/JP	JP	0.3	O
					SG	1	18	AL/JP	JP	0.3	O
					SG	1	11	AL/JP	JP	0.3	O
					SG	1	8	AL/JP	JP	0.3	O
					SG	1	9	AL/JP	JP	0.3	O
					UG	1	8	AL/JP	JP	0.3	O
			13/03/76	-14 to -08	SG	1♂	5	AL/JP	JP	0.6	FO
					SG	4♂?	21	AL/JP	JP	0.6	FO
					SG	1♀?	10	JP	JP	0.6	FO
					SG	1♂	8	JP	JP	0.6	FO
					SG	1	7	JP	JP	0.6	FO
					UG	1	--	JP	JP	0.6	FO

continued ...

Table 1. Concluded.

Habitat Type	Location	Length of Census Strip (m)	Survey Date	Temp °C	Species[1]	Number	Flushing Distance (m)	Veg'n at Flushing Site[2]	Cover[3]	Snow Depth (m)	Snow Condition[4]
			26/03/76	----	SG	1♂	4	AL/JP	JP	0.3	W
					SG	1♂	3	AL/JP	JP	0.3	W
					SG	1♂	14	JP	JP	0.3	W
					SG	1♂	1	JP	JP	0.3	W
					SG	1♂	3	AL/JP	JP	0.3	W
Black Spruce Muskeg	1-95-9-W4	6250	27/01/76	-18 to -15	PT	1	2.5	PM/SA	PM	0.5	O
					PT	4	6	PM/SA	PM	0.5	O
			19/02/76	-25 to -10	PT	1♂	4	SA	PM/SA	0.5	O
			10/03/76	-12 to -04	PT	8	13	SA/PM	PM	0.6	FO
					PT	3	5	SA/PM	PM	0.6	FO
					PT	5	12	SA/PM	PM	0.6	FO
			24/03/76	-04 to +04	PT	1	7	PM/SA	PM	0.4	C

[1] UG - Unidentified grouse
RG - Ruffed grouse
SG - Spruce grouse
PT - Willow ptarmigan

[2,3] PM - Black spruce
SA - Salix
AL - Alder
PT - Aspen
PG - White spruce
JP - Jackpine
WA - White spruce/deciduous

[4] O - Old granular snow
F - fresh or light snow < 15 cm
W - wet snow
C - frozen or crusted snow

Table 2. Number of observations per kilometre walked on winter upland bird plots.

Habitat Type	Number of Observations per km Walked			
	Ruffed Grouse	Spruce Grouse	Unidentified	Total
Aspen/White Spruce Plot	0	0	0.1	0.1
Aspen/Shrub Plot	0.05	0	0.05	0.1
Mature Jack Pine Plot	0	0.95	0.16	1.11
Black Spruce Muskeg Plot	0	0	0	0

Table 3. The number of Spruce and Ruffed Grouse observations per kilometre walked on each summer breeding bird plot (1976 and 1977).

Plot	Grouse observations per kilometre walked in a habitat	
	Ruffed Grouse	Spruce Grouse
Bitumount Aspen Plot	0.32	0.04
McClelland Aspen Plot	0.13	0
Aspen-Jack Pine Plot	0.02	0.22
Mature Jack Pine Plot	0	0
Young Jack Pine Plot	0	0.14
Young Mixed Forest Plot	0.05	0.46
Mature Mixed Forest Plot	0.19	0.04
River Transect	0.14	0.03
LaFont Island	0.27	0
Hartley Creek Valley Plot	0.45	0.25
Interface Plot	0.03	0.42
Tall Bottomland Willow Plot	0.46	0
Deciduous Shrub Fen Plot	0	0
Open Bog Plot	0	0
Sedge Fen Plot	0	0
Young Black Spruce Plot	0.02	0.10
Mature Black Spruce Plot	0	0.32
Bitumount Muskeg Plot (1976)	0	0.28
Bitumount Muskeg Plot (1977)	0	0.24
Tamarack Plot	0	0

Table 4. Average flushing distances for spruce grouse and ruffed grouse on the breeding bird plots during 1976 and 1977.

	Spruce Grouse		Ruffed Grouse	
	N	X ± S.D. (metres)	n	X ± S.D. (metres)
Bitumount Aspen Plot	0		4	
McClelland Aspen Plot	0		4	
Aspen-Pine Plot	13	10.50 ± 7.54	0	
Young Scrub Jack Pine Plot	8	23.20 ± 6.65	0	
Young Mixed Forest Plot	19	7.26 ± 4.36	0	
Hartley Creek Valley Plot	4	14.50 ± 11.81	3	11.33 ± 9.86
Interface Plot	15	17.93 ± 10.91	0	
Young Black Spruce Plot	5	15.60 ± 5.22	0	
Mature Black Spruce Plot	8	8.12 ± 5.25	0	
Bitumount Muskeg Plot (1976)	12	8.17 ± 4.84	0	
Bitumount Muskeg Plot (1977)	8	15.00 ± 13.10	0	
TOTAL	92	12.38 ± 9.15	11	14.55 ± 11.25

Sharp-tailed Grouse dancing grounds were located on the open bog plot and the tamarack plot. The dancing ground on the tamarack plot was used by approximately 12 birds while that on the open bog plot was utilized by approximately 9 birds.

3.4 DISCUSSION

3.4.1 Winter Upland Birds

Theoretically, the numbers of upland birds recorded on the winter census plots were too low to provide for calculation of densities according to the King census method. King has prescribed certain minimum requirements in order that reliable density estimates be obtained, namely: (1) the census area should be at least 10.36 km^2; (2) the census lines should cover at least 48.28 km; and (3) at least 40 birds should be flushed (Trippensee 1948). Such requirements would be difficult to meet in most practical situations, especially during winter. Therefore, we proceeded with our surveys in spite of the fact that our census areas were approximately 1 km^2 with 5 to 6.25 km of census line.

With the foregoing qualifications in mind, the King formula was applied to the three surveys of jack pine in which at least five Spruce Grouse were flushed (Rusch and Keith 1971b:807 used a minimum of ten flushed birds for estimating populations). These data yielded density estimates of 0.516, 0.468, and 0.833 grouse/ha. Dennis (1966) found densities of Ruffed Grouse of 0.358 and 0.619/ha during winter months in southern Ontario. Rusch and Keith (1971b) derived January to March population estimates of 119 to 194 Ruffed Grouse on a 10.36 km^2 area (densities of 0.116 to 0.189/ha). While our estimates are of the same order of magnitude for Spruce Grouse in jack pine, we are not confident of their reliability nor their representativeness.

Ruffed Grouse and Spruce Grouse may form loosely associated flocks in winter and the movements of individuals may be somewhat restricted; the strip census method is appropriate if an adequate sample can be obtained. Willow Ptarmigan, on the other hand, are quite mobile, moving about in relatively tight flocks of variable size. Thus, their distribution with respect to the habitat is quite different from the other grouse. No attempt has been made to estimate densities of ptarmigan from the available data.

Superficially at least, the census data (Table 1) suggest certain habitat relationships and relative densities of winter upland birds in the four habitats examined. These implications, however, are modified in some cases by supplemental observations. The fact that the Spruce Grouse winter diet consists predominantly of pine needles has been recorded by others (Johnsgard 1973) and it is reasonable to conclude as well that the somewhat open jack pine cover type with considerable alder understory is attractive as winter shelter. Although not evidenced in Table 1, several Ruffed Grouse were observed incidentally in the jack pine unit, more than in the aspen/shrub and aspen/white spruce stands. This is regarded as an anomaly since Ruffed Grouse generally are considered to feed on the buds of deciduous shrubs and trees (particularly poplar) during winter. The only deciduous species available in the jack pine unit was alder.

Based on the scheduled surveys, Willow Ptarmigan were observed almost exclusively on the muskeg plot where there were numerous patches of willow mixed with an open black spruce tree canopy. One was observed on the aspen/shrub plot. Incidental observations during the winter, however, provided indications that ptarmigan ranged considerably throughout other habitat types, all of which had the common characteristic of openness of the tree canopy: tracks (observed from the air and suspected to be those of ptarmigan) were evident along the margin of McCelland Lake and within the string bog areas adjacent to that lake. Numerous ptarmigan were seen along roadways, feeding on willow and young aspen in the ditches, and some were seen in Fort McMurray near the Clearwater River. Ptarmigan population in the oil sands probably will vary considerably, possibly depending on a combination of population densities and food supplies in the Artic.

Numbers of Ruffed Grouse observed, both during the surveys and incidentally, were below what one would have expected on the basis of casual observations the preceding fall and subsequent spring.

Nothing has been learned of the numbers and distribution of Sharp-tailed Grouse during winter.

Conclusive results regarding winter populations of upland birds in the oil sands would require a much more intensive study than that conducted in 1976, probably much more intensive than AOSERP is prepared to undertake.

3.4.2 Breeding Upland Birds

The estimation of upland bird densities is hampered by behavioral factors within the populations. The drumming of male Ruffed Grouse and the quieter courtship display of Spruce Grouse are the only auditory cues given by the birds which can be used to locate their positions. The display of the Spruce Grouse is very unostentatious and is easily missed during a census. Thus the actual flushing of the birds becomes the most common means of observing this species. Additional behaviour patterns render the complete censusing of grouse populations very difficult. Ruffed and Spruce Grouse will "freeze" in a position and let an observer walk by and will only flush if the observer passes in close proximity. From the data in Table 4 it appears that both species will flush when an observer passes within 15 m. As the survey lines on the plots were 100 m apart, there was an area, approximately 70 m wide, between survey lines in which grouse were not likely to flush. Therefore the data in Tables 2 and 3, subject to the above qualifications, should be used only to provide comparisons between different habitat types. The number of observations per kilometre was utilized in an attempt to overcome the inherent deficiencies in our sampling technique which did not meet the requirements necessary for use of the King method.

The data collected on the breeding bird study plots suggest that display, nesting and brood requirements of Spruce and Ruffed Grouse can all be found within a single forest cover type. On the majority of plots both courtship displays and broods were observed. Consequently the term breeding habitat as used in this discussion includes all three of the breeding requirements. On some plots where grouse observations were limited to one or two sightings and the type of observations did not fall into one of the three categories, the grouse species was not considered to breed on the plot. Because of this, Ruffed Grouse were considered to breed on only eight of the study plots even though they occurred on 11, while Spruce Grouse were considered to breed on only 10 of the 12 plots where they occurred.

The habitat parameters preferred by breeding Ruffed Grouse are a deciduous-dominated tree canopy with a substantial shrub understory. Although a deciduous tree canopy is important, the form and type of shrub growth that occurs in the understory is of greater significance to Ruffed Grouse. Data contained in Table 3 can be used to illustrate this point. From comparison of the Bitumount and McClelland aspen plots (for both, Stratum 1 was comparable, but the shrub strata were quite different), it is evident that the Bitumount plot had a greater number of observations. Stratum 2 of the McClelland Lake plot, which occurred under a dense aspen canopy averaging 18 m in height, was open to dense and seldom over 1 m tall. The Bitumount aspen forest was characterized by a Stratum 3 canopy which averaged 15 m in height and by a Stratum 2 canopy which was usually dense to closed and from 1 to 3 m in height. The Bitumount plot was also better suited to Ruffed Grouse because it had more berry-producing shrub species than the McClelland plot. Low bush cranberry, rose, chokecherry, pincherry, willow, and alder, which all provide food and shelter, may form substantial canopies under an aspen forest. Dense canopies of alder do not appear to be as important to Ruffed Grouse. The orders *Hymenoptera* and *Colioptera* appear to be the insects most frequently utilized by grouse chicks (Edminster 1947) and a shrub understory provides excellent cover and an abundance of these insect species (Edminster 1954). During the summer, fruiting shrubs and forbs constitute the major food source for adult Ruffed Grouse (Edminster 1947). As winter approaches, persistent fruits, buds, twigs, and catkins become the dominant food types for both adults and juveniles. These habitat requirements were present on both the tall bottomland willow plot and the Hartley Creek plot. Sharp (1963) showed that the density of a grouse population increased significantly when clearings were created in their habitat. The Bitumount aspen plot contained the majority of the above requirements, but lacked clearings. This may have limited Ruffed Grouse populations somewhat.

Spruce Grouse breed in a variety of habitats, ranging from dry scrub jack pine forests to wet mature black spruce muskegs. The presence of coniferous trees and their distribution are two parameters regulating breeding Spruce Grouse population. Coniferous trees need not be the dominant tree species on the plot but they must form a substantial portion of the tree canopy. Dense stands of conifers appear to be the preferred breeding habitat as evidenced by the distribution of adult grouse on plots which had tree canopies of varying densities. For example, observations of Spruce Grouse on the Bitumount muskeg plot were most common in areas of dense black spruce while the grouse were absent from areas of open black spruce. The young mixed forest plot, which had the highest Spruce Grouse population of any of the plots, was dominated by coniferous tree species which usually formed a dense canopy. While black spruce and jack pine appear equally suitable to breeding Spruce Grouse, the xeric sites where jack pine is usually located and the hydric sites where black spruce is usually located greatly influence the Spruce Grouse populations. The Stratum 1 vegetation, which is affected by the water regime, is important in determining Spruce Grouse population levels. A dense moss layer and/or a dense to open Stratum 1 are preferred by Spruce Grouse. Consequently, a jack pine stand with a scattered Stratum 1, bare patches of ground, and/or a lack of forest floor litter is unsuitable as breeding habitat for Spruce Grouse. The young mixed forest, which was on a mesic site, was dominated by jack pine in Stratum 3 and grasses and forbs in Stratum 1, and consequently provided excellent breeding habitat for Spruce Grouse. The berries of *Vaccinium* species, found in the ground stratum of most coniferous forests, represent the main food source for adults during the summer (Pendergast and Boag 1970).

Two nests were found on the plots; one was in dense moss and was concealed by overhanging coniferous branches, the other was in deciduous leaf litter at the base of an aspen. The nesting requirements of Spruce Grouse, therefore, appear quite variable.

The nesting habitat of Sharp-tailed Grouse was neither observed nor determined. It does appear, however, from a limited number of summer observations, that open forests and muskegs are the preferred breeding habitats. Sharp-tailed Grouse utilize open bogs for dancing grounds, even though the bogs may be very wet (in which case male grouse dance on the moss hummocks). Sharp-tailed Grouse with young were observed in jack pine forest in the vicinity of the Mildred Lake camp. In Michigan, Sharp-tailed Grouse selected nest sites under or in close proximity to woody cover and brood habitat contained more woody cover than nesting habitat (Amman 1957).

3.4.3 Seasonal Distributions of Upland Gamebirds

Although the volume of data is not sufficient to provide a definitive delineation of the seasonal distributions of resident upland gamebirds, habitat preferences of these birds can be suggested. It appears that Spruce Grouse will choose significantly different habitats during summer and winter. Jack pine forests appear to have an ingress of Spruce Grouse during fall and winter as the data in Tables 2 and 3 illustrate. Incidental observations on the mature jack pine breeding plot during winter field work revealed the presence of Spruce Grouse on this plot. No grouse were detected during the summer terrestrial breeding bird surveys on this plot. In a study conducted in Alberta, Pendergast and Boag (1970) found the winter diet of Spruce Grouse to consist almost entirely of lodgepole pine needles. In the McClelland Lake area during the fall of 1976, groups of Spruce Grouse were abundant in the jack pine and the utilization of this habitat reflects a change in the diet of Spruce Grouse from predominantly berries to jack pine needles. Plot data and incidental observations also suggest that winter populations of Spruce Grouse in other habitats were at densities lower than summer populations. Crichton (1963), working in Ontario, indicated that Spruce Grouse fed almost exclusively on jack pine needles during the winter even though there was an abundance of black spruce. This apparent dependence on jack pine needles may explain the decrease of Spruce Grouse during the winter in habitats without jack pine. Another possible explanation of the preference for jack pine is that the more open canopies which characterize jack pine stands permit the sunlight to penetrate to the forest floor and that this allows the birds to sun.

Because of the small sample size, the seasonal movements of Ruffed Grouse cannot be adequately determined. Summer terrestrial breeding bird plot data and incidental observations during winter plot lay-outs suggest that a portion of the population is resident year-round in certain habitats. However the magnitude or even the occurrence of fluctuations between winter and summer densities in a habitat cannot be predicted from the data. Other studies have indicated that buds and twigs are the main diet of Ruffed Grouse during winter (Johnsgard 1973). Since most of the habitats sampled had substantial shrub layers, the winter food supply should be adequate. The amount of roosting cover may be important in determining the emigration from a habitat.

Sharp-tailed Grouse were not observed in the study area during the winter and therefore the winter habitat preferences of this species are currently unknown.

3.5 CONCLUSIONS

Conclusions as to the status of upland gamebirds in the oil sands area are based on data collected between 1975 and 1977. Because of the low population densities and the characteristic behaviour patterns of these birds, this data base is somewhat restricted. However the following conclusions are drawn but must be qualified by the above limitations.

1. Spruce Grouse are the most abundant upland gamebird in the area. Ruffed Grouse follow in abundance, while Sharp-tailed Grouse currently occur at relatively low densities. Willow Ptarmigan occur in the study area between October and early April but in currently undetermined numbers.
2. The overall population level of Sharp-tailed Grouse may increase with clearing and the subsequent reclamation of presently forested lands.
3. Spruce Grouse and possibly Ruffed Grouse utilize different habitats in different seasons, reflecting a change in diet that is related to the annual seasonal weather cycles. Spruce Grouse require jack pine needles as a food source during the winter months.
4. The major impact of the oil sands development on grouse derives from the destruction of their habitat when large areas are cleared preparatory to stripmining. The construction of cut-lines does not appear to affect grouse populations (and in fact may even enhance the habitat for upland gamebirds). The effects of pollutants are, as yet, undetermined. The potential effects of disturbance and hunting pressure on upland gamebirds are currently undetermined and may require investigation. The Spruce Grouse is the species which can be expected to suffer the most from increased access into new areas. Due to the unwary nature of this species, Spruce Grouse populations will suffer heavy losses from hunters. Consequently, special attention should be paid to the management of this species.
5. Reclamation of mined areas is possible for Spruce Grouse and Ruffed Grouse. While the reclamation of muskegs for Spruce Grouse is highly unlikely, this loss is mitigated by the ability of Spruce Grouse to use a variety of habitats. Consequently, a mixed forest with some jack pine, a varied shrub understory and dense

dwarf-shrub/forb ground cover would be suitable habitat for both Ruffed and Spruce grouse and also excellent for small bird populations.

6. Further studies are needed in order to fully understand the biology of upland gamebirds in the AOSERP area. However, any future studies will have to be labour and money intensive.

4. NON-GAMEBIRDS

4.1 OBJECTIVES

The general objective of this portion of the project is to describe the baseline states of terrestrial bird resources in the oil sands area in order to delineate and assess the potential effects of development and provide guidelines for reclamation.

The specific objectives addressed during 1976 and 1977 field studies were:

1. Determine habitat requirements for each species or group of species with particular emphasis on critical areas and develop an annotated list of characteristics that define the habitat of each species or group of species that will be suitable for mapping potential habitats from airphotos and ground surveys.
2. Census terrestrial birds in a variety of habitats in the Muskeg River watershed, McClelland Lake area and Athabasca River valley in order to fulfill the above objective.
3. Describe the vegetation of study sites and correlate these parameters with bird census data.
4. Utilizing the above information and working with photo interpreters, develop a set of ecological maps at a scale of 1:50 000 for each species or group of species for the AOSERP area, indicating production capabilities with emphasis on critical areas.

4.2 METHODS

4.2.1 Migration Methodology

During the spring and fall of 1976, transect surveys were carried out to determine migration chronology and to investigate the possibility of assessing habitat use by migrants. Spring migration studies began on 17 April and continued until 15 May; fall migration studies began on 19 July and continued until 30 September.

Seven transects were surveyed during both periods. These were divided among three observers, each of whom surveyed his transects in rotation, as often as weather permitted. The transects varied between 1 and 8 km in length with the majority of them transversing more than one habitat type.

The survey method consisted of walking the transect line and recording all birds seen or heard. Each observation was ascribed a point on the transect line plus a distance co-ordinate to the right or left. Transects were surveyed at a speed of 2 to 3 km/h in the spring. This speed was reduced to 1 to 1.5 km/h in the fall to provide more intensive coverage.

The following habitats were sampled:

1. Jack pine forests (young and mature);
2. Aspen forests (young, immature and mature);
3. Mixed forests (immature and mature);
4. Athabasca River Valley forests (spring only);
5. Lakeshore forests (McClelland Lake);
6. Mature black spruce muskeg;
7. Mature tamarack fen;
8. Willow scrubland;
9. Sedge marsh (fall only); and
10. Sandbar/shoreline survey for shorebirds--conducted by motorboat on the Athabasca River (fall only).

Appendix 8.8 contains the instructions for the migration census while Appendix 8.9 contains the actual census form.

4.2.2 Migration Transect Habitat Description Methodology

Habitat variations were present within each transect, thus none of the transects could be said to typify any one habitat. Consequently, habitat was quantified separately for each of the marked 50 m segments in a band 25 m to each side of the transect. As the transects often followed "edge" situations, the left and right sides of the transects were quantified separately, yielding 25 x 50 m blocks.

Habitat was described according to the following criteria (see Appendix 8.10):

1. Tree canopy (above 5 m): height, density, densest layer(s) of foliage, species composition;
2. Shrub layer (0.5 to 5 m): same as tree canopy;
3. Ground cover layer (less than 0.5 m but not including mosses and lichens): density and composition (forbs, grasses, sedges, heaths, etc.);
4. Mosses and lichens: approximate percent coverage within the block;
5. Detritus: same as mosses and lichens;
6. Bare ground: same as mosses and lichens; and
7. Deadwood: absent, present, abundant.

4.2.3 Breeding Bird Methodology

Breeding bird studies were carried out from 16 May to 18 July 1976 (although, where the spring migration and breeding bird studies were conducted on the same plot, the migration data were used to supplement the breeding bird data for early breeding species) and from 2 May to 10 July 1977.

The "mapping method", endorsed by the International Bird Census Committee (IBCC 1970), was utilized for determining terrestrial bird densities. This method involves the repeated mapping of the locations of singing males on a grid map which represents the study plot. When the data from all surveys are transcribed to single-species summary maps, clusters of observations appear for each territorial male. The number of clusters (i.e., breeding territories) on a given plot can then be used to make a density estimate for that habitat, the standard unit of comparison being the number of territories per 100 ha.

Grids comprising 4, 6 or 7 parallel lines, 100 m apart, were used for most habitats. When this type of grid was not possible, plot lines followed physical features of the habitat (e.g., the edge of a river or river valley, the periphery of a marsh or island). When sufficiently extensive stands of habitat were available, plots were made as large as possible, consistent with the necessity of completing a census during the morning song peak. When not limited by extent of habitat, the plots varied between 28 and 60 ha, depending on penetrability of the habitat.

The study conformed to the IBCC standards wherever possible; however, logistical constraints dictated two divergencies. The IBCC recommendations state: "Different routes through the plot should be used, with different starting and ending points, distributed as evenly as practicable among the visits". Due to manpower shortages, the layout of a "different route" (i.e., a second set of grid lines) was completed on only one of the standard plots (McClelland Lake aspen forest). However, surveys were begun alternately from opposite ends of the plot in all cases. The IBCC also states: "The minimum number of visits needed in a closed habitat is ten ...". Problems with access logistics rendered this impossible for two of the plots. Ten or more visits were made to all the other study plots. Thirteen standard grid plots and seven irregular plots were censused and described (Figure 4). In addition, one breeding bird line transect was censused to determine the usefulness of line transect data for population density estimates and bird/habitat correlations.

The Bitumount aspen forest plot (74E/VU6664) was a standard grid of 30 ha (1976).

The McClelland Lake aspen forest plot (74E/VU7968) was a standard grid (two sets of lines) of 42.25 ha (1976).

The aspen-jack pine forest plot (74E/VU6756) was a standard grid of 42 ha (1977).

The young jack pine forest plot (74E/VU7873) was a standard grid of 35 ha (1976).

The mature mixed forest plot (74E/VU5764) was a standard grid of 32.5 ha (1976).

The young mixed forest plot (74E/VU7848) was a standard grid of 37 ha (1977).

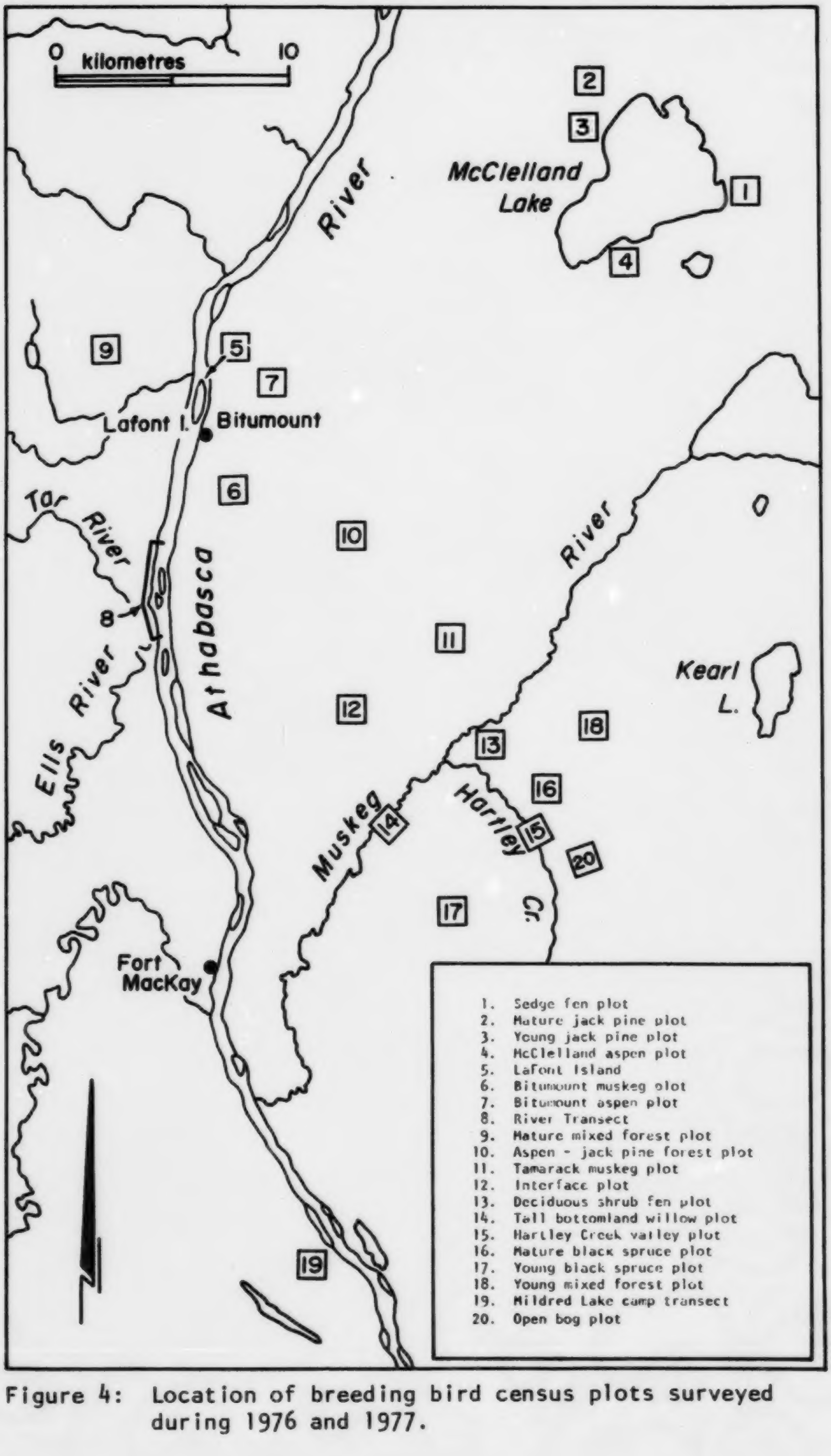
0
kilometres
10
River
McClelland
Lake
2
3
1
4
9
5
7
Lafont I.
Bitumount
6
Tar
River
10
River
Athabasca
8
11
Kearl
L.
Ells
River
12
13
18
16
Muskeg
14
Hartley
15
20
Cr.
17
Fort
MacKay
19
1. Sedge fen plot
2. Mature jack pine plot
3. Young jack pine plot
4. McClelland aspen plot
5. Lafont Island
6. Bitumount muskeg plot
7. Bitumount aspen plot
8. River Transect
9. Mature mixed forest plot
10. Aspen - jack pine forest plot
11. Tamarack muskeg plot
12. Interface plot
13. Deciduous shrub fen plot
14. Tall bottomland willow plot
15. Hartley Creek valley plot
16. Mature black spruce plot
17. Young black spruce plot
18. Young mixed forest plot
19. Mildred Lake camp transect
20. Open bog plot

Figure 4: Location of breeding bird census plots surveyed during 1976 and 1977.

The river valley transect (74E/VU5953) was a line 4.15 km long which paralleled the bank of the Athabasca River, 25 to 150 m inland. The observer walked the transect line, then canoed downriver to the starting point, recording birds throughout. For analytical purposes, the river transect has been divided into its two main habitat components and treated as two strip plots: the river valley mixed forest plot was 2.1 km long and had an area of 33 ha, while the bottomland mature balsam poplar/scrub willow plot was 1.55 km long and 27 ha (1976).

A 4.5 km survey line followed the periphery of LaFont Island (74E/VU6162) which is situated in the Athabasca River. The island was 1860 m long and 380 m wide at its widest point and had an area of 50 ha (1976).

The Hartley Creek plot consisted of a survey line on either side of the Hartley Creek valley. A 900 m stretch of valley was sampled: the plot was 16 ha (1977).

The Interface plot (74E/VU6749) was a standard grid of 37.5 ha (1977).

The bottomland mature willow plot (74E/VU6944) was trapezial in shape, 750 m long at its longest point, 550 m wide at its widest point, and 28 ha in area (1977).

The deciduous shrub fen plot (74E/VU7347) was a standard grid of 30 ha (1977).

The open bog plot (74E/VU7743) was irregularly shaped and 16 ha in area (1977).

The sedge fen plot (74E/VU8471) was 19 ha and consisted of a survey line 4.0 km long which followed the periphery of a sedge marsh (1976).

The young black spruce plot (74E/VU7240) was a standard grid of 35 ha (1977).

The mature black spruce plot (74E/VU7645) was a standard grid of 16.5 ha (1977).

The Bitumount muskeg plot (74E/VU6358) was a standard grid of 30 ha (1976 and 1977).

The tamarack muskeg plot (74E/VU7252) was a standard grid of 37 ha (1977).

The camp transect (74E/VU6725) was a 2.5 km transect running south and east from the AOSERP Mildred Lake camp (1976).

Because bird populations are known to fluctuate from year to year, it was necessary to survey one of the 1976 study plots again in 1977 in order to monitor these fluctuations and thus establish the comparability of 1976 and 1977 data. The Bitumount muskeg plot was chosen because of its diversity of species and its accessibility. Censuses were conducted by the same observer both years in order to eliminate any possibility of observer bias.

4.2.4 Breeding Bird Plot Habitat Description Methodology

Detailed habitat descriptions were collected for each of the breeding-bird survey plots and transects. During 1976, due to manpower constraints, only alternate lines were described (with the exception of the river valley transect on which all blocks were described). During 1977, complete coverage was obtained on all plots except the Muskeg River and Hartley Creek plots. Because of the irregular shape of these plots, it was impossible to divide the entire plot into 50 x 50 m blocks. The same set of habitat parameters were used during 1976 and 1977 and the parameters assessed for each 50 x 50 m block include: general habitat type; overall canopy densities of Stratum 1 (0 to 0.5 m), Stratum 2 (0.5 m to 5 m), and Stratum 3 (5 to 7 m); distribution, relative density and height of the five most common species in each stratum; density and height of standing dead trees; types and densities of other non-living plant material; presence and relationships of interfaces; soil texture and drainage; topographic features; and the presence of water. The vegetation of Stratum 1 was divided into the following classes: shrubs, forbs, grasses, sedges, horsetails and club-mosses. Subjective, visual estimations were made for height, relative density, and distribution for all strata. The habitat instructions and forms are contained in Appendices 8.13 and 8.14.

4.2.5 Data Analysis

Minor variations occurred within most of the habitats studied. The young black spruce stand, for example, contained: "pure young black spruce", "young black spruce with some willow present", "open black spruce averaging 2 m tall", "dense to closed young black spruce averaging 2 m tall", "dense to closed young black spruce averaging 4 m tall" and so forth. The quarter-hectare-at-a-time approach to habitat description allowed us to isolate, within the plots, subplots in which certain habitat conditions prevailed. Calculations of population densities for each of these subplots yielded a basis for comparing the effects on bird population of specific variations in habitat. As a result of the large plot sizes used in this study, it was possible in many cases to get fairly large subplot samples--frequently the subplots exceeded the 10 ha minimum plot size recommended by the IBCC (1970). Population calculations for those subplots which were less than 10 ha in size are numerically less trustworthy and have been used to suggest patterns of abundance rather than to give accurate measures of abundance.

Maximum population densities of several bird species are less than 5 territories per 100 ha, while other species attain densities of nearly 200 territories per 100 ha. As a result, the relative importances of different species are rather unevenly represented in the total population density figure for any habitat. Accordingly, a system was designed whereby all species are weighted equally. For the study plots and many of the larger subplots, the population density of each bird species was calculated as a percentage of the maximum density for that species. These percentages represent an approximation of the degree of saturation of a habitat by a given species and have been incorporated into a histogram for each plot. These will be referred to as species/habitat saturation histograms.

In addition, a "coefficient of integral niches (C.I.N.)"--a measure of the number of species niches which are integral as opposed to incidental to a given habitat--has been calculated for plots and the larger subplots. The C.I.N. is simply the number of species present at densities greater that 25% of their maximum population density. Maxima have been taken from Erskine[1] (1971, 1972, 1976) or from our plot data. When these figures were clearly too low, estimates from our subplot data have been substituted. Table 5 presents the maxima used for the species/habitat saturation histograms and for calculations of C.I.N. An explanation of these concepts is presented in Section 4.4.

Conventional descriptive and analytical statistics have been used sparingly in this report due to several factors. Logarithm-based diversity indices have not been used for reasons which will be explained in Appendix 8.15. Standard deviation and standard error calculations have been used sparingly in habitat descriptions and have been avoided for breeding bird population densities. Many data in habitat description (e.g., tree height) represent, in their raw form, averages for a 50 x 50 m block of habitat. While the mean of such figures is meaningful, standard deviation is not. Breeding bird population density figures are estimates. As such, the concept of a calculated "95% confidence limit" is meaningless.

The breeding bird, migration transect, and all habitat description data were collected so as to permit computer entry. Multivariate analysis was to be used to solve community structure and the habitat relationships of bird species and species groups. However, the extra time and funding required for entry and analysis were never available; consequently the statistical significance of the data sets was never determined.

4.3 RESULTS

4.3.1 Migration Studies

Data on the chronology of migration have been incorporated into the annotated list (Appendix 8.1).

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[1] Usage was restricted to study plots 10 ha or larger in the boreal forest region, within the range of the appropriate subspecies. Data from forests infested with spruce budworm or jack pine sawfly have not been used.

Table 5. Maximum population densities of bird species in Boreal Canada.

Species	Density
Mallard	7
Blue-winged Teal	4
American Wigeon	7
Common Merganser	2
American Kestrel	4
Spruce Grouse	0.42 obs./km walked
Ruffed Grouse	0.45 obs./km walked
Sandhill Crane	2
Sora	68
Common Snipe	12
Spotted Sandpiper	20 (E)[a]
Greater Yellowlegs	11
Lesser Yellowlegs	3
Short-billed Dowitchers	4
Great Horned Owl	2
Common Nighthawk	5[b]
Common Flicker	12[b]
Pileated Woodpecker	3
Yellow-bellied Sapsucker	30
Hairy Woodpecker	8[b]
Northern Three-toed Woodpecker	6
Eastern Kingbird	20[b]
Eastern Phoebe	20[b]
Yellow-Bellied Flycatcher	20 (E)
Alder Flycatcher	50[b]
Least Flycatcher	195[b]
Western Wood Pewee	30[b]
Olive-sided Flycatcher	11
Tree Swallow	6[b]
Gray Jay	12
Blue Jay	12[b]
Black-billed Magpie	2
Common Raven	2
Black-capped Chickadee	12[b]
Boreal Chickadee	12[b]
Red-breasted Nuthatch	15
Winter Wren	20[b]
American Robin	37 (E)
Hermit Thrush	24[b]
Swainson's Thrush	52
Ruby-crowned Kinglet	60 (E)
Solitary Vireo	19 (E)
Red-eyed Vireo	126 (E)
Philadelphia Vireo	57 (E)
Warbling Vireo	23 (E)

Table 5. Concluded.

Species	Density
Black-and-white Warbler	34 (E)
Tennessee Warbler	112
Orange-crowned Warbler	18
Yellow Warbler	80[b]
Magnolia Warbler	85 (E)
Cape May Warbler	15 (E)
Yellow-rumped Warbler	80 (E)
Black-throated Green Warbler	43 (E)
Bay-breasted Warbler	63 (E)
Blackpoll Warbler	40 (E)
Palm Warbler	120[b]
Ovenbird	138
Northern Waterthrush	62
Conneticut Warbler	10[b]
Mourning Warbler	25 (E)
Common Yellowthroat	200 (E)
Wilson's Warbler	87
Canada Warbler	56
American Redstart	197 (E)
Red-winged Blackbird	192
Rusty Blackbird	20 (E)
Common Grackle	39
Western Tanager	23
Rose-breasted Grosbeak	17
Evening Grosbeak	8[b]
Purple Finch	30[b]
Pine Siskin	8
Savannah Sparrow	41 (E)
LeConte's Sparrow	38
Sharp-tailed Sparrow	40[b]
Dark-eyed Junco	112 (E)
Chipping Sparrow	75 (E)
Clay-colored Sparrow	100[b]
White-throated Sparrow	76
Fox Sparrow	46
Lincoln's Sparrow	122
Swamp Sparrow	116
Song Sparrow	105(E)

[a] E denotes data taken from Erskine (1971, 1972, 1976).
[b] Estimates made from subplot data.

During the initial planning of the 1976 field studies, the inherent problems in migration studies were recognized. The low observability of most species during migration limits the amount of data that can be collected. The possibility that individual species may not have specific habitat requirements during migration was also acknowledged. Despite these limitations the authors felt an attempt should be made to determine the usefulness of migration studies in the AOSERP area.

After conducting our studies it was found that both of these limitations appear to be operative and consequently our data were of limited use. Yellow-rumped Warblers and Dark-eyed Juncos were the only two species which were observed in significant numbers. These two species were observed in every habitat type sampled except for sandbars and sedge marshes. For these two species, this limited amount of data would suggest a general southward movement through the study area as opposed to a habitat-oriented migration.

4.3.2 Breeding Bird Results

Data collected on the breeding bird study plots have been incorporated into the annotated list (Appendix 8.1) and the 1976 and 1977 breeding bird results (Appendix 8.2). The tables contained in Appendix 8.2 give a complete breakdown of breeding bird populations found on the study plots and within subplots. Table 6 contains a summary of breeding bird data collected on the study plots during 1976 and 1977.

4.3.3 Habitat Description Results

Habitat quantification data have been incorporated into a descriptive summary for each of the plots (Appendix 8.3).

4.4 DISCUSSION

4.4.1 The Relative Value of the Oil Sands Area to Avifauna.

It is a common misconception that boreal habitats are avifaunally impoverished, characterized by sparse to moderate

Table 6. Summary of Breeding Bird Data Collected During 1976 and 1977.

Plot	Total Number of territories per 100 ha	Total Number of breeding species	Coefficient of integral niches
Bitumount Aspen Plot (1976)	452	16	11
McClelland Aspen Plot (1976)	142	11	4
Aspen-Jack Pine Plot (1977)	206	24	13
Mature Jack Pine Plot (1976)	67	7	6
Young Jack Pine Plot (1976)	91	9	4
Mature Mixed Forest Plot (1976)	515	36	21
Young Mixed Forest Plot (1977)	230	22	10
River Valley Mixed Forest - River Transect (1976)	430	34	16
LaFont Island (1976)	395	23	N/A
Bottomland Mature Balsam Poplar/Scrub Willow-River Transect (1976)	545	26	N/A
Tall Bottomland Willow Plot (1977)	499	32	16
Hartley Creek Valley Plot (1977)	352	26	N/A
Interface Plot (1977)	289	21	N/A
Deciduous Shrub Fen Plot (1977)	358	14	8
Open Bog Plot (1977)	273	12	8
Sedge Fen Plot (1976)	479	8	6
Young Black Spruce Plot (1977)	233	20	6
Mature Black Spruce Plot (1977)	203	15	11
Bitumount Muskeg Plot (1976)	571	30	N/A
Bitumount Muskeg Plot (1977)	418	29	N/A
Tamarack Muskeg Plot (1977)	176	14	11

numbers of relatively few species. Erskine (1977) does much to dispel this misconception, finding that breeding bird population densities in boreal habitats vary from 80 (jack pine) to 800 (various habitats) pairs per square kilometre (100 ha). A density of 800 pairs per square kilometre "is comparable to all but the richest hardwood stands of the Eastern deciduous forest" (Erskine 1977:23). Population densities encountered in the AOSERP study varied from 47 (jack pine) to 634 (riparian balsam poplar and willow) pairs per square kilometre. Densities of individual species in the oil sands area were comparable to those found elsewhere in Canada from methodologically similar studies; in fact, many species were found at the highest densities ever encountered in boreal Canada.

Thus oil sands habitats appear capable of supporting an abundance of breeding birds which is typical of the boreal forest region on a national basis.

A total of 169 bird species are known to have bred in the 28 500 km^2 AOSERP study area. In an area of similar size in the Eastern deciduous forest (a band 80 km wide along the north shore of Lake Erie), 176 species are known to have bred (the latter figure derived from Godfrey 1966). The difference (9 species; i.e., 5%) is minimal.

Thus the oil sands area is not characterized by an impoverished avifauna. Abundance (Erskine 1977) and diversity (Godfrey 1966) in the deciduous forest zone at the southernmost extremity of Canada are only marginally greater than those found in the oil sands study area.

4.4.2 Discussion of Ramifications of Bird Population Fluctuations and Comparability of 1976 and 1977 Data.

Population studies were conducted in 20 habitat types, ten in 1976 and ten in 1977. Because bird populations fluctuate from year to year, any comparison of habitats sampled in two different years must be predicated on an understanding of the relative population levels of both years. Accordingly, a breeding bird census was conducted on the Bitumount muskeg plot in 1976 and 1977 in order to monitor fluctuations in bird populations.

Total population densities on the Bitumount muskeg plot fell from 561 territories per 100 ha in 1976 to 418 territories per 100 ha in 1977--a net decline of 25% (Appendix 8.2, Table 39) Declines of up to 80% in five of the nine commonest species accounted for 75% of the total population decline. Overall, fourteen species declined more than 25% while only six species increased more than 25%. A discussion of these fluctuations follows in which the probable ramifications on the comparability of 1976 and 1977 data are considered.

Many bird species exhibit apparent variability in their habitat preferences from year to year. When the population level of a given species is low, that species will usually breed only in its optimal habitats. An increase in population will result in increased densities until the optimal habitats are saturated. When this occurs, the species will overflow into suboptimal habitats, where it will breed, but at much lower population densities. Similarly, when population levels of a given species decrease from a very high level, the overflow habitat will become vacant before the population densities in the optimal habitats are much affected.

Thus it is quite possible that, when its population levels are high, a species can exhibit a 100% decline in one habitat while remaining unchanged in another. This phenomenon has been noted in the British Common Birds Census: " ... it is the suboptimal habitats ... which show the greatest fluctuations at times of high density" (Williamson 1969:13). When population levels of a species are low and optimal habitats are not saturated, population fluctuations tend to be more uniform.

This overflow effect places certain limitations on the credibility of population fluctuation data for species at high population levels:

1. When optimal habitat is saturated, substantial fluctuations can take place in overall population levels without affecting population densities in that optimal habitat. Thus a plot in a species' optimal habitat can fail to register population fluctuations of that species.
2. When an increase or decrease is registered on a plot (and the sample size is adequate), the fact of an increase or decrease is credible, but the percentage need not accurately reflect the actual change in the population level of that species over a wider area.

Tennessee Warbler population density on the Bitumount muskeg plot declined from 84 territories per 100 ha in 1976 to 50 territories per 100 ha in 1977. Tennessee Warbler populations on this plot in 1976 were an excellent example of the saturation/overflow effect (Figures 5, 6; Appendix 8.2, Table 39). In 1976, population densities were greatest in a band of 2.5 to 6 m tall willow with scattered spruce and poplar trees and along the interfaces between forest and willow scrub. Much lower densities occurred in habitats which are marginal for the Tennessee Warbler: black spruce muskeg, tamarack fen and short willow scrub (see Appendix 8.1 for Tennessee Warbler habitat preferences). In 1977, population densities were somewhat lower in the optimal habitat, but the overflow habitat was vacant. Thus the decline figure for the plot (40%) is meaningless in that it represents a composite of a 100% decline in suboptimal habitat and a 28% decline in preferred habitat (Appendix 8.2, Table 50). However, similar patterns of abundance of Tennessee Warblers were evident on the 1977 study plots. While their population levels were slightly lower than anticipated in such prime habitats as the Hartley Creek valley and the interface plot (Appendix 8.2, Tables 32 and 33), Tennessee Warblers were either uncommon or absent in such marginal habitats as deciduous shrub fen and young black spruce tamarack bog (Appendix 8.2, Tables 34, 37 and 40).

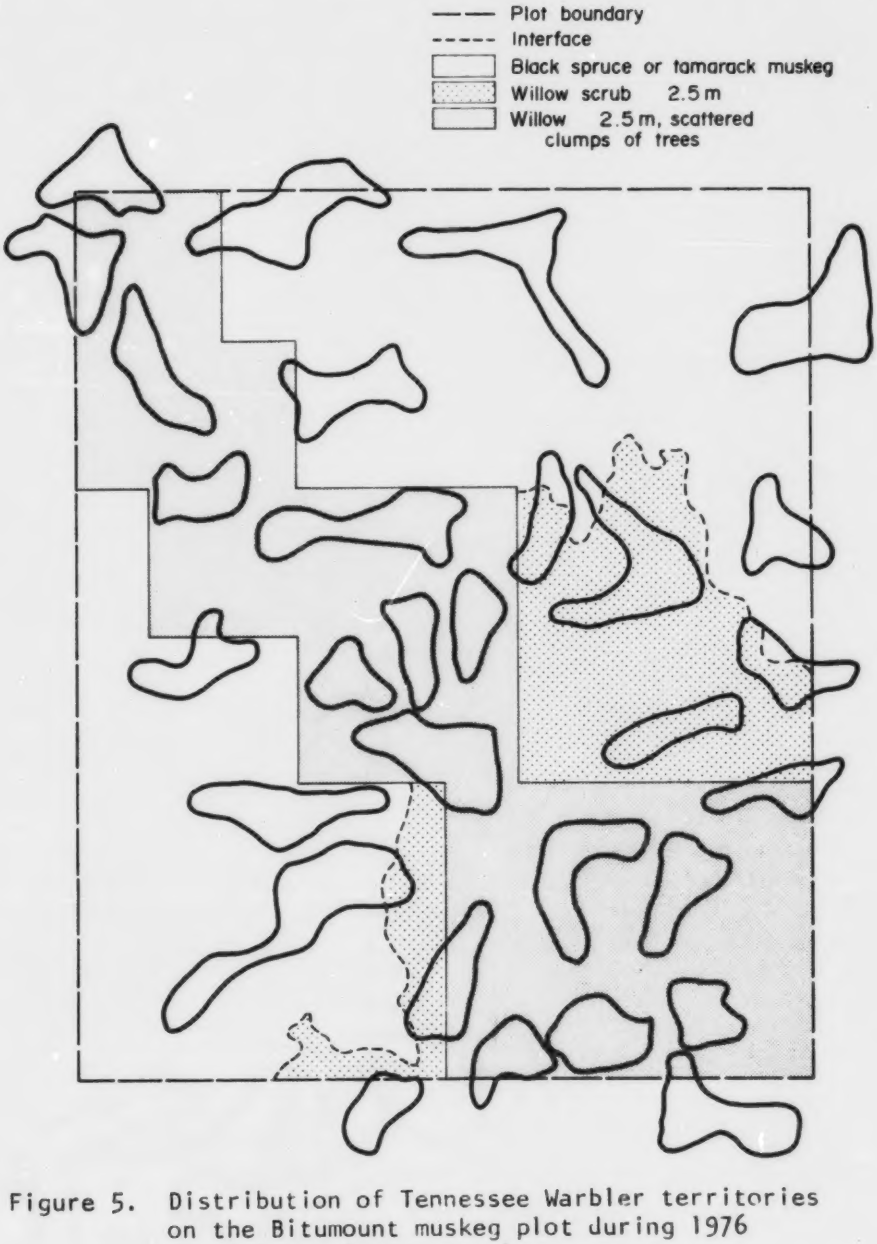
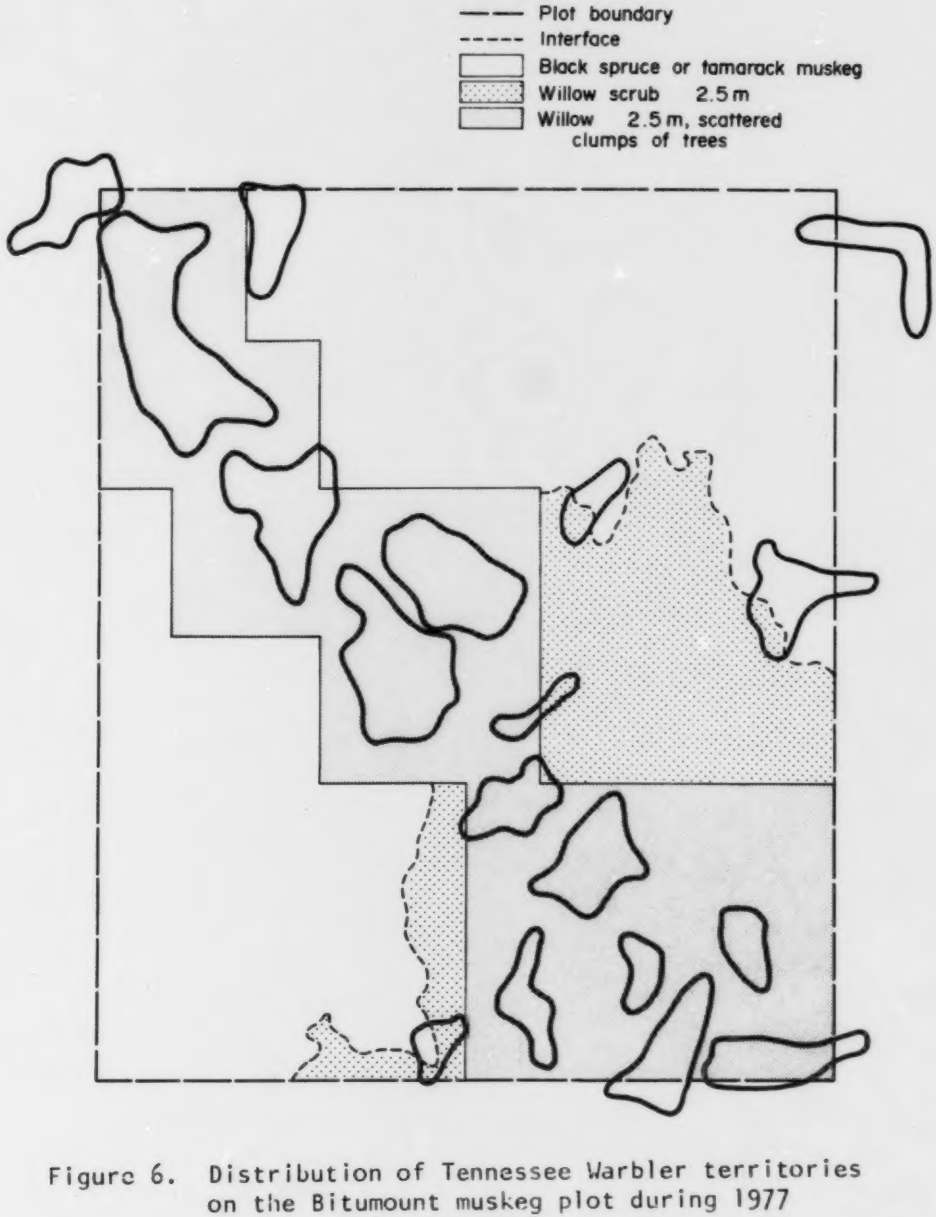

Plot boundary
Interface
Black spruce or tamarack muskeg
Willow scrub 2.5 m
Willow 2.5 m, scattered clumps of trees

Figure 5. Distribution of Tennessee Warbler territories on the Bitumount muskeg plot during 1976 (a high population year).



Plot boundary
Interface
Black spruce or tamarack muskeg
Willow scrub 2.5 m
Willow 2.5 m, scattered clumps of trees

Figure 6. Distribution of Tennessee Warbler territories on the Bitumount muskeg plot during 1977 (a low population year).

The Canadian Breeding Bird Survey (Finney et al. 1978) noted apparent declines in Tennessee Warbler population levels across Canada, although these declines were statistically significant only in the Maritime provinces. No data were collected in boreal western Canada.

Wilson's Warbler population density on the Bitumount muskeg plot declined from 52 territories per 100 ha in 1976 to 21 territories per 100 ha in 1977. Due to uncertainty as to precisely what constitutes the preferred habitat of Wilson's Warbler, the authors are uncertain as to whether an overflow effect was present on the plot in 1976 (see Appendix 8.1 for Wilson's Warbler habitat preferences). Thus, while it is reasonably certain that an overall population decline did take place, the exact significance of the 60% decline on the Bitumount muskeg plot is not clear.

Ruby-crowned Kinglet population density on the Bitumount muskeg plot declined from 22 territories per 100 ha in 1976 to seven territories per 100 ha in 1977. This decline may well have been due to severe weather in the Ruby-crowned Kinglet's wintering grounds in the Eastern United States, where "There is no doubt....kinglets.... suffered great losses" (Gee 1977:968). That this species was apparently confined to its preferred habitat (dense, black spruce dominated forests) in 1976 and 1977 suggests that the decline in population in 1977 was relatively uniform.

The Canadian Breeding Bird Survey (Figure 7) noted a significant decline in Ruby-crowned Kinglet numbers in eastern and central Canada.

An increase was noted in the aspen parklands and prairie regions, although "... it is very difficult to assess the validity of (this change)... since very few birds are involved" (Finney 1978). No data were collected in the Western boreal region.

Orange-crowned Warbler population density on the Bitumount muskeg plot declined from 15 territories per 100 ha in 1976 to three territories per 100 ha in 1977. This 80% decline probably reflects an actual decline in Orange-crowned Warbler population levels in the study area; however, the sample size is too small for absolute certainty.

	Maritimes	Southern Ont. Southern Que.	Central Ont. Central Que.	Central Prairie Provs	British Columbia
Yellow-bellied Sapsucker	⇩		⬇		
Winter Wren	⇩		⇩		
Ruby-crowned Kinglet	⇩		⇩	⇧★	
Tennssee Warbler	⇩		⬇	⬇★	
Rose-breasted Grosbeak	⬆	⇩	⬇	⇩★	
Pine Siskin	⬆	⬆		⇩	⇩
Dark-eyed Junco	⬆		⬆	⇩	

⇩ Population decrease registered, statistically significant

⬇ Population decrease registered, not statisitically significant

⇧ Population increase registered, statistically significant

⬆ Population increase registered, not statisitically significant

★ Small sample size precludes full confidence in data

Figure 7. Summary of the Canadian Breeding Bird Survey for selected species (Finney et al. 1978).

Chipping Sparrow population density on the Bitumount muskeg plot declined from 48 territories per 100 ha in 1976 to 33 territories per 100 ha in 1977. This 31% drop probably reflects an actual decline in Chipping Sparrow population levels in the study area.

Nine other species declined more than 25% between 1976 and 1977. The apparent decline in populations of two of these species, Hermit and Swainson's Thrushes, was at least partly due to underestimation of their populations in 1977 when unsubstantiated territories of both species were present on the plot. The declines in populations of the other seven species (Yellow-bellied Flycatcher, Western Wood Pewee, Gray Jay, Black-and-white Warbler, Purple Finch, Sharp-tailed Sparrow and Dark-eyed Junco) cannot be ascribed any significance, as sample sizes were too small.

Populations of six species increased more than 25% between 1976 and 1977. The apparent increase in populations of Boreal and Black-capped Chickadees and Yellow-rumped Warblers was at least partly due to underestimation of their populations in 1976, when unsubstantiated territories of all three species were present on the plot. The increase in populations of the other three species (Solitary and Red-eyed Vireos and LeConte's Sparrow) cannot be ascribed any significance, as sample sizes were too small.

The weather in the study area during the winter of 1976-77 was unusual (Table 7), but we can only speculate as to its effects. The milder than usual temperatures may have resulted in higher than usual survival rates among year-round residents (e.g., chickadees, jays and certain woodpeckers). The mild temperatures notwithstanding, the reduced snow depth occasioned greater than usual frost penetration. This "deep freeze", and the subsequent severe scouring of streambeds in riffles during runoff, exacted a heavy mortality among insect (bird food) populations overwintering in the benthic layers of streambeds (R. Crowther, pers. comm. 1978). The reduced snowfall may have resulted in drier than usual conditions in the spring, thus rendering the Bitumount muskeg plot more suitable for some species (e.g., vireos and LeConte's Sparrow), and less suitable for others (e.g., Sharp-tailed and Swamp Sparrows).

Table 7. Precipitation and mean temperature in Fort McMurray, winter 1976-77 compared to 27-year average.

MONTH	Mean Temperature Fort McMurray 1976-77 (°C)	Mean Temperature Fort McMurray 27-Year Average (°C)	Precipitation in mm. Fort McMurray 1976-77	Precipitation in mm. Fort McMurray 27-Year Average
OCTOBER	1.9	3.1	46.3	24.1
NOVEMBER	-5.0	-8.4	8.3	24.9
DECEMBER	-16.8	-16.9	17.1	24.1
JANUARY	-18.7	-21.5	5.9	21.1
FEBRUARY	-3.3	-16.6	7.4	17.3
MARCH	-5.1	-9.4	28.3	18.3

Data taken from Longley and Janz (1978).

Weather in the winter range of migrants probably had more effect on the oil sands avifauna than did the local weather. The eastern United States had, in 1976-77, "one of its severest winters on record" (Gee 1977:968) as was mentioned in the discussion of the decline in Ruby-crowned Kinglet populations. "Other species which were or may have been reduced by winter mortality, at least in some areas, include ... Common Flicker, Yellow-bellied Sapsucker, Winter Wren ..." (Gee 1977:968).

Summary. Of the 33 species which bred on the Bitumount muskeg plot in either or both years twenty declined, at least nominally between 1976 and 1977, while only seven increased. The gross decline of all species combined (167 terr./100 ha) exceeded the gross increase (24 terr./100 ha) by a factor of seven.

While the declines are adequately monitored for only five species, the authors feel that declines of similar magnitude occurred in at least nine other species (Table 8). Declines in seven of these species were noted in the Co-operative Breeding Bird Survey in Canada (Figure 7).

Five of the commonest species declined substantially, and the declines of two other species (Dark-eyed Junco and Purple Finch), while inadequately shown by plot data, are supported by casual observations. Casual observations suggest similar declines of seven more species. It is likely, then, that total populations were somewhat lower in 1977 than in 1976; the 25% figure from the Bitumount muskeg plot cannot be generalized, but suggests the order of magnitude of population changes.

Declines of 15% to 50% seem likely, depending on the prevalence in a particular habitat of those species whose declines were most dramatic. Species richness (the number of species breeding in a given habitat) probably diminished in most habitats in 1977 due to the abandonment of "overflow habitats by many species".

Table 8. Species definitely or apparently present in reduced numbers in 1977.

Species which demonstrably declined on Bitumount muskeg plot	Decline apparent from casual observations (i.e., species not present or represented by inadequate sample size on Bitumount muskeg plot)
Ruby-crowned Kinglet	Yellow-bellied Sapsucker
Orange-crowned Warbler	Least Flycatcher
Tennessee Warbler	Winter Wren
Wilson's Warbler	Ovenbird
Chipping Sparrow	Rose-breasted Grosbeak
	Purple Finch
	Dark-eyed Junco
	Pine Siskin
	Song Sparrow

Effects of this decline on the coefficient of integral niches (C.I.N.) should be minimal; it was, as will be explained in the next section, designed not to reflect natural population fluctuations. The species/habitat saturation histograms incorporate species richness, the C.I.N., and a derivative of total population; as such, they should be affected by declining populations of individual species (see Figures 16 and 17), although fluctuations across the 25% line should be minimal in homogeneous habitats.

4.4.3 Habitat Evaluation

4.4.3.1 *Biological Context: Findings of Other Studies.* Most studies conducted to date on terrestial non-game birds have concentrated on three aspects of bird biology:

1. Breeding bird population levels in various habitats (N. America), regions (Europe), and years (N. America and Britain);
2. Habitat selection by various bird species; and
3. The relationship between bird species diversity (B.S.D.) as calculated using the Shannon-Weaver formula and various habitat parameters, particularly [foliage height diversity (F.H.D.) as calculated using the Shannon-Weaver formula].

Very little has been done in the field of habitat evaluation per se, and the usefulness of information from these other categories is limited.

The usefulness of information in the first category is limited by two factors: inadequacy of habitat descriptions; and the lack, until very recently, of standardized methodology (IBCC 1970) to ensure comparability of results. Given these limitations, it is not surprising that no one has ventured to synthesize a habitat evaluation system on the basis of a literature search! Erskine (1977) gives an excellent summary of the ranges in population densities and numbers of species found in various boreal habitats, as well as the bird species indigenous to those habitats. This summary is based on his own extensive research across Canada plus other studies conducted using the same standardized methodology. Erskine's stated aim is to provide "some baseline data against which the impact of developmental proposals may be assessed" (Erskine 1977:9). Erskine found that both abundance and diversity of breeding avifauna vary considerably in given habitat types. The factors informing these variations (which are the focus of this study) are not formally addressed. The information available in the second category [as summarized in Godfrey (1966), Salt and Salt (1976) and many others] is useful largely with respect to the individual species accounts presented in Appendix 8.1.

The information contained in the third category is also of limited usefulness. A number of studies have been conducted using the Shannon-Weaver formula for data analysis (e.g., MacArthur and MacArthur 1961; MacArthur et al. 1966; Moss 1978). All are academic in nature and concentrate on the relationship between B.S.D. and F.H.D., and thus the use of F.H.D. as a predictor of B.S.D. (for an explanation of these concepts, see MacArthur and MacArthur 1961). That some correlation seems to exist cannot be denied, but many exceptions have been found (e.g., Cody 1966, 1968; Balda 1969; Willson 1974; Carrothers et al. 1974; Stamp 1978) and the correlation is not clearly understood. In addition, as is explained in Appendix 8.15, the B.S.D. function is not well suited to habitat evaluation, thus its relationship to F.H.D. is of only academic interest to us. The only technique that was incorporated from these studies was the division of habitat into three height classes for quantification purposes. The importance of clumped foliage, particularly in open habitats, has been noted (e.g., Hoope et al. 1973). Consequently, the relationship between foliage and open space in a horizontal plane (referred to in this report as horizontal foliage/space diversity), as well as the concept of foliage height diversity (as opposed to the F.H.D. function), have been considered constantly during the interpretational and analytical stages of this study.

4.4.3.2 Techniques and Criteria used for Habitat Evaluation. As evaluation of habitat with respect to terrestrial non-game birds is a relatively unexplored field, there exists neither a set of formalized criteria for evaluation, nor a set of techniques for "measuring" habitats according to those criteria.

We decided that three criteria were important:

1. The number of bird species for which a habitat is suitable;
2. The degree of suitability for those bird species; and
3. The suitability of habitat for the more sensitive stenoecious species (i.e., those bird species with relatively narrow niche tolerances, whose habitats are likely to undergo reduction due to oil sands development).

Terrestrial bird populations in a given habitat are conventionally expressed using four calculations: the densisty per 100 ha of each individual species, the combined density of all species per 100 ha (total population), the number of species (species richness) and, frequently, the B.S.D. function. These calculations are variously of limited use, or of no use, in evaluating habitats according to our criteria.

The density of each individual species is an excellent measure of the suitability of a habitat for that species when taken in the context of the breeding biology of that species. For example, a dense (and therefore biologically significant) population of Sandhill Cranes, Great Horned Owls or Pileated Woodpeckers (three or four pairs per 100 ha) is numerically dwarfed by even a low (and therefore biologically unimportant) population density of Least Flycatchers, Common Yellowthroats or American Redstarts (20 or 30 pairs per 100 ha). As nearly 100 species bred on our study plots, this "context" involves a colossal amount of information. Some interpretive technique is therefore necessary.

There are two difficulties implicit in the use of total population density as a measure of habitat value: 1) total population density in a given habitat can vary considerably from year to year, as this study observed on the Bitumount muskeg plot (Appendix 8.2, Table 39); and 2) the maximum population density attainable varies from species to species. Thus, a habitat which is suitable for a few species which can attain very high densities will have a very high total population density (e.g., the sedge fen plot, where Red-winged Blackbirds and Swamp Sparrows had a combined density of 308 terr./100 ha), whereas a habitat which is suitable mainly to species which do not ever attain high densities will have a very low population density (Appendix 8.2, Table 25).

Species richness observed on a given plot may be strongly influenced by the variation in habitat present on that plot. A plot containing a variety of habitat types will support a more diverse breeding bird population than would any one of its component habitat types. When a plot is used to evaluate a habitat type, the relative "purity" of the stand will affect the species richness; on the young black spruce plot, for example 8 of the 21 species on the plot, 38% were associated with "stand impurities" (Section 4.4.3.4.4).

Even relatively small stand impurities can have fairly substantial effects on the species richness observed on a study plot. The species richness may also vary from year to year with fluctuations in populations as overflow populations colonize and vacate the habitat. Thus the species richness represents the number of species found on a particular study plot in a particular year, but does not necessarily reflect either the importance of that habitat to those species, or the actual diversity of breeding avifauna associated with the pure habitat. Therefore an interpretive technique is again necessary.

The B.S.D. function is an interpretive technique which has been widely used in American bird studies as a measure of the diversity of avifauna that a habitat is observed to support. The B.S.D. function actually measures a combination of two factors: the species richness, and the numerical (which is not the same as biological) equability of the individual species densities.

Because of the academic nature of these studies, the concept of value is never formally addressed. However, two assumptions are implicit: that diversity is desirable and that the B.S.D. function is a valid and accurate measure of that diversity.

We did not use the B.S.D function in this study; its characteristics are not consistent with our evaluation criteria, as will be explained. Erskine (1977:11) says of diversity indices: "I remain sceptical both of their validity and their usefulness". A discussion of the limitations of the B.S.D. function is presented in Appendix 8.15.

In lieu of the B.S.D. function, two interpretive techniques were designed for use in this study: the species/habitat saturation histogram, and the C.I.N.

The C.I.N. is essentially a derivative of species richness. Its purpose is to present a numerical approximation of the number of bird species for which a habitat is suitable.

The species/habitat saturation histograms present graphically, for each habitat, the percentage of its maximum population density at which each bird species bred. This in turn represents an approximation of the degree of suitability of the habitat for each species and, thus, the shape of the rough triangle formed by all the bars in a given histogram represents an approximation of the overall value of that habitat.

4.4.3.3 Significance and Limitations of Interpretive Techniques. One of the parameters utilized for habitat evaluation in this study was: "the number of bird species for which a habitat is suitable". This number can differ substantially from the number of species found on a study plot representing a habitat type.

The breeding bird population found on any study plot can be divided into three categories:

1. Integral: those bird species which belong in a particular habitat type--i.e., those species for which the habitat is truly suitable.

2. Incidental: those bird species associated with "impurities" in a habitat (e.g., conifer associated species breeding around a copse of spruce in an otherwise pure deciduous forest). These bird species are not actually associated with the habitat type the plot is intended to sample.
3. Marginal: those bird species for which the habitat is suboptimal, but which use it as an overflow habitat in high population years when more suitable habitat is saturated.

The purpose of the C.I.N. is to separate the number of species integral to a habitat from those occupying incidental or marginal niches.

The underlying assumption of the C.I.N. (and the species/habitat saturation histograms) is that bird species attain high population densities only in optimal habitat and that, under normal conditions, a saturation point (a maximum density) can be reached. The maxima presented in Table 5 are assumed to represent the maximum breeding density potentials for the bird species breeding in the AOSERP study area. The C.I.N. values and the species/habitat saturation histogram percentages have been computed in terms of these maxima. The coefficient of integral niches for any given habitat is simply the number of species in that habitat which are breeding at more than 25% of their maximum densities.

Populations of bird species occupying incidental niches are limited by the prevalence of the particular "impurity" with which they are associated. Given a reasonable degree of habitat purity in the study plot, populations of incidental species will remain well below 25% of their maximum densities.

Populations of species occupying marginal habitat are assumed rarely to exceed 15 or 20% of their maximum densities. (This assumption cannot be proven except in terms of another assumption, that species only attain high densities in sutiable habitats). Thus the C.I.N., by "registering" only those species which are breeding at more than 25% of their maximum densities, represents an approximation of the number of species for which a habitat is suitable. Table 9 presents a ranking of the study habitats according to C.I.N. values. (The 25% cutoff cannot be supported, but a 30 or 35% cutoff yields a very similar ranking.)

The C.I.N. is not foolproof; overflow populations probably do occasionally exceed 25% of maximum densities, and populations in suitable habitat can, after sustaining severe losses, drop below 25% of the maximum. (The authors feel this occurred in 1977 with Ruby-crowned Kinglets on the young black spruce study plot.)

The C.I.N. is unaffected by population fluctuations and thus is useful for comparisons of habitats sampled in different years (see Appendix 8.15 for explanation).

The C.I.N. is less accurate when applied to population data for small sample plots. (Approximations have been given for some 6 to 12 ha subplot samples, although sample size of 17 ha or greater is far preferable).

The C.I.N. should not be used for non-homogeneous habitats; i.e., habitat mixtures (see Appendix 8.15 for explanation).

The species/habitat saturation histograms are essentially a derivative of the individual species population densities. The histogram portrays each individual species' population level expressed as a percentage of the maximum density for that species. Thus the length of each bar represents an approximation of the suitability of the habitat for that bird species. Thus the histograms address the second evaluatory parameter, "the degree of suitability of habitat for bird species". (The derivation of two histograms from raw population data is illustrated in Appendix 8.15.

The species/habitat saturation histograms are also useful with respect to the third evaluatory parameter, "the suitability of a habitat for the more sensitive stenoecious bird species". (A discussion of stenoecious species is presented in Section 4.4.4).

Table 9. Ranking of Studied Habitats by C.I.N. values.

Plot	C.I.N.	Species Richness	Total Population
Overmature Mixed Forest Subplot	23	33	583
River Valley Mixed Forest Plot	16	34	430
Tall Bottomland Willow Plot	16	32	499
Aspen-Jack Pine Plot	13	24	206
Bitumount Aspen Forest Plot	11	16	452
Mature Black Spruce Plot	11	15	203
Tamarack Muskeg Plot	10	14	176
Young Mixed Forest Plot	10	22	230
Open Bog Plot	8	12	273
Deciduous Shrub Fen Plot	8	14	358
Young Black Spruce Plot	6	20	233
Sedge Fen Plot	6	8	479
Open Mature Jack Pine Subplot	6	7	47
Closed Mature Jack Pine Subplot	4	6	88
Young Jack Pine Plot	4	9	91
McClelland Aspen Plot	4	11	142
LaFont Island	N/A	23	395
Balsam Poplar/Scrub Willow Plot	N/A	26	545
Hartley Creek Valley Plot	N/A	26	352
Interface Plot	N/A	21	289
Bitumount Muskeg Plot (1976/1977)	N/A	30/29	571/418

The main limitation of the species/habitat saturation histogram is that it is affected by annual population fluctuations (see Figures 16, 17). This means that any habitat will appear more suitable for a species during a high population year for that species than it will during a low population year for that species.

4.4.3.4 Evaluation of Studied Habitats

4.4.3.4.1 Upland Deciduous Forests

Text References

Plot	Plot density data	Subplot data	Habitat Description
Bitumount Aspen Plot	Table 21	Table 41	P. 279
McClelland Lake Aspen Plot.	Table 22	Table 42	P. 281

Our observations suggest that upland deciduous forests in the AOSERP study area are almost invariably dominated by trembling aspen. White Birch is present as a minor component in most stands, but is rarely dominant. Tree canopies are typically closed or dense to closed and exhibit little height diversity. The upland deciduous stands sampled in this study were typical in both of these respects. The evaluation of aspen forest as bird habitat involved assessing the effects on diversity and abundance of breeding avifauna of stand height, and of density, species composition and height of the shrublayer, and the presence of white spruce in the understory.

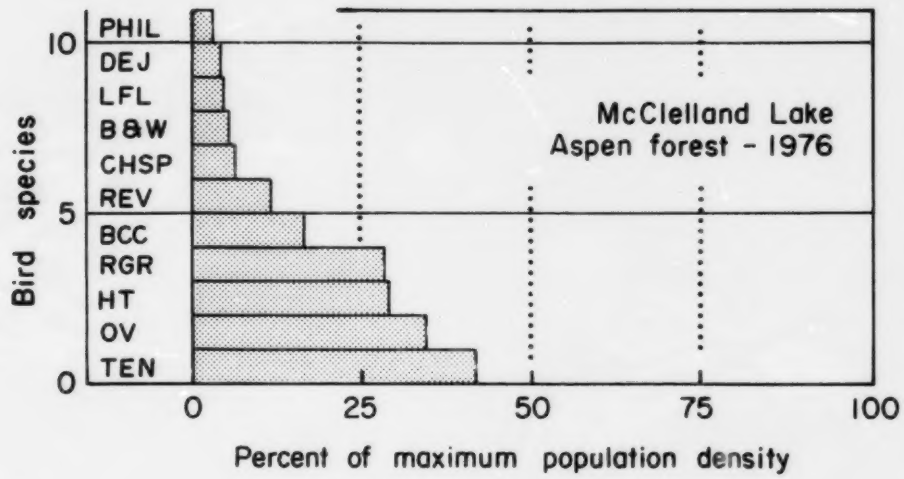
The results indicated that a shorter (14 m average, slightly taller in the ravines) stand with a taller and denser understory supported a much greater abundance and diversity of breeding avifauna than did a taller (19 m average) stand with a shorter, open understory. The presence of scattered white spruce trees appeared to have little effect beyond attracting small numbers of Chipping Sparrows and Dark-eyed Juncos.

Subplot analysis of the McClelland Lake Aspen Forest plot suggested that Stratum 2 density was not the major factor limiting abundance and diversity of avifauna. Approximately 0.25% of the plot had an open-to-dense shrublayer. The bird population data from this subplot (not listed in this report) were almost identical to the data for the rest of the plot.

The species/habitat saturation histograms for the two plots (Figure 8) reveal that five species (Black-and-white Warbler, Black-capped Chickadee, Swainson's Thrush, Least Flycatcher and Rose-breasted Grosbeak), which are normally associated with tall shrubs and the bottom of the tree canopy, were present in large numbers on the Bitumount aspen plot, but were sparse or absent on the McClelland Lake aspen plot. These five species account for most of the difference in the C.I.N. values of the two plots (4:11).

The Bitumount aspen plot was characterized by a dense to closed shrublayer, generally 1 to 2 m in height. Between the top of the shrublayer and the bottom of the aspen canopy were scattered 8 to 12 m tall birches, and scattered thickets of 5 to 8 m tall willow or alder. Thus, foliage was present at all levels between the ground and the treetops. Horizontal foliage/space diversity was also considerable in the area between the shrub and aspen foliage layers.

The McClelland Lake aspen plot was characterized by a vast unfoliated gap, generally in excess of 10 m, between the top of the shrub foliage and the bottom of the tree canopy. The presence of foliage between shrub and aspen layers on the Bitumount aspen plot, and the absence of such foliage on the McClelland Lake aspen plot, appear to have been the major factors affecting the capacity of the habitats to support diversity and abundance of breeding avifauna.



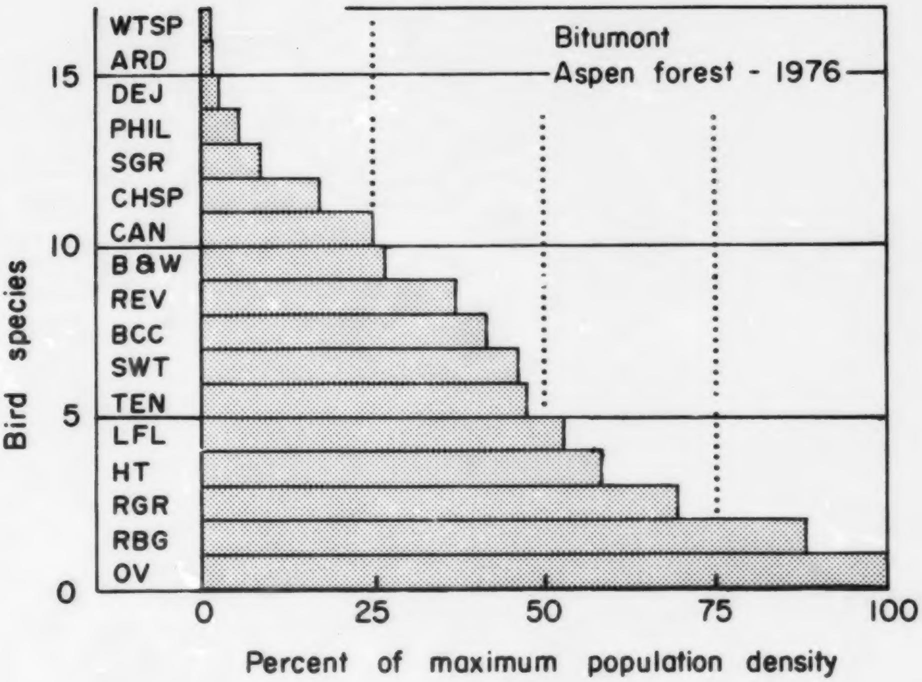


Figure 8. Species/habitat saturation histograms for McClelland and Bitumount Aspen Forest Plots.

Subplot analysis (or, in some instances, simple habitat correlations) delineated the habitat preferences of most bird species present on the aspen forest plots (Table 10), but a synthesis of the habitat relationships of the community as a whole was not possible.

During the surveys, one portion of the Bitumount aspen plot appeared to be more densely populated than the rest of the plot. This portion was treated as a subplot (Subplot #3) and was found to support a greater abundance of most species than did the rest of the plot. The combination of habitat factors involved, however, was beyond the capabilities of hand analysis. Multivariate statistical analysis would probably have succeeded in this regard.

Plant Species:

The shrublayer on the McClelland Lake aspen was dominated rose. This may, in addition to the sparsity and shortness of the shrublayer, have been another factor limiting bird populations. Casual observations elsewhere in the study area have led the authors to believe this to be the case. At least two species, Least Flycatcher and Swainson's Thrush, showed a clear preference for a willow as opposed to alder subcanopy.

Summary: Value to breeding avifauna.

Upland deciduous forest varies in value from very low to fairly high. The presence of very tall alder or willow between the shrublayer and aspen canopy considerably increases the suitability of a stand for several bird species. The presence of an unfoliated gap between shrub and tree foliage probably reduces the value of a stand.

A dense or closed shrublayer, taller than 1 m,is preferred by several species to a sparse and shorter shrublayer. A rose-dominated shrublayer is probably less suitable to several species than a willow- or cranberry- (*Viburnum*) dominated shrublayer.

Table 10. Habitat associations of bird species in upland deciduous forests.

Bird Species	Habitat preferences in upland deciduous forest plots
Ruffed Grouse	Not clear. Appeared to prefer Bitumount aspen plot to McClelland Lake aspen plot.
Least Flycatcher	Clumps of 4 to 8 m tall willow. Horizontal foliage/space diversity important.
Black-capped Chickadee	Not clear. Probably prefers abundant shrublayer and subcanopy.
Hermit Thrush	Not clear. Less common in ravines.
Swainson's Thrush	Prefers clumps of 4 to 8 m tall willow. Horizontal foliage/space diversity probably important.
Red-eyed Vireo	Probably prefers a tree canopy with openings to a closed canopy (i.e., horizontal foliage/space diversity). The presence of birch, alder, willow and/or aspen below the tree canopy is also preferred. Horizontal foliage/space diversity below the densest layer of the tree canopy seems to be preferred.
Philadelphia Vireo	Not clear.
Black and White Warbler	Limited to damper ravine sites where scattered layer of 6 to 12 m tall alder or birch is present below densest layer of tree canopy. Tree canopy with some horizontal foliage/space diversity (i.e., openings) scattered layer of alder, birch and willow beneath closed canopy is also suitable.

continued ...

Table 10. Concluded.

Bird Species	Habitat preferences in upland deciduous forest plots
Tennessee Warbler	Tree canopy with some horizontal foliage/space diversity (i.e., openings). Scattered layer of alder, birch and willow beneath closed canopy is also suitable.
Ovenbird	Not clear. Less common in ravines. May prefer shorter stands. May prefer abundant low cover: if so, shrubs 1 m tall are as acceptable as forbs.
Canada Warbler	Limited to ravines.
American Redstart	Limited to areas in which tree canopy open.
Rose-breasted Grosbeak	Foliage height diversity below densest layer of tree canopy is important to this species, but exact preferences not clear.
Dark-eyed Junco	Never far from spruces (small mixture adequate).
Chipping Sparrow	Areas with some spruce and scattered clumps of 6 to 8 m tall willow are preferred. Horizontal foliage/space diversity important, probably for song perches.
White-throated Sparrow	Limited to areas with open tree canopy and abundant shrublayer and subcanopy.

A dense as opposed to closed tree canopy may be preferable to at least two bird species; this provides horizontal foliage/space diversity. The presence of horizontal foliage/space diversity is probably important at all levels between 5 m and the densest layer of the tree canopy.

4.4.3.4.2 Pine Forests

Text References

Plot	Plot density data	Subplot data	Habitat Description
Mature Jack Pine Plot	Table 25	Table 43	P. 287
Young Jack Pine Plot	Table 24	None	P. 288

In order to evaluate pine forest as bird habitat, the authors set out to assess the effects of three variables: stand height, tree canopy density, and the absence or presence of a deciduous understory stratum. The lack of extensive stands of pine forest with deciduous understory necessitated reverting to casual observations in small stands for this evaluation.

Pine forests appear to be invariably poor as breeding bird habitat as regards total population, species richness and the C.I.N. (Tables 24 and 25).

The mature jack pine plot has a very low species richness (7), but this was a least partially attributable to the homogeneity of the stand, and the concomitant absence of incidental niches (as reflected by the similarity of species and C.I.N., 7 and 6, respectively). The higher population and species richness found on the young jack pine plot were at least partly attributable to the presence of alder swales, young aspen trees and mature jack pine trees. The low C.I.N. (4) probably more accurately reflects the value of this habitat.

The subplot analysis which was conducted on the mature jack pine plot (Table 43 and Figure 9) suggested that several species prefer an open-canopied jack pine forest to a closed-canopied one.

Casual observations revealed a higher species richness in jack pine forests (with alder understory). Breeding populations of black and white and Tennessee Warblers, among other species, were usually present. Jack pine forests with lush grass-dominated ground cover were observed to support populations of Ovenbirds and Hermit thrushes.

The near absence of low shrublayer (0.5 to 1.5 m) and ground cover which characterized both jack pine plots resulted in sparse cover. These conditions, which are characteristic in jack pine stands, probably result in low population levels.

Foliage height diversity/horizontal foliage/space diversity:

A greater abundance and diversity of breeding was present in open mature jack pine than in closed mature jack pine. This probably reflects a response to foliage height diversity in the tree stratum or to horizontal foliage space diversity or both.

Due to the increased light penetration of the canopy in the open stand, the tree foliage extended farther down on the tree, generally to within 2 or 3 m of the ground. In the closed stand, foliage rarely extended below 6 m, and little horizontal foliage/space diversity was present.

Summary:

Pine forest appears to be relatively poor habitat for breeding birds. Slightly higher abundance and diversity have been noted in pine habitats in which: the tree stratum is open; there is an understory of alder shrubs; or the ground cover is lush and dominated by grasses instead of scattered heaths and lichen.

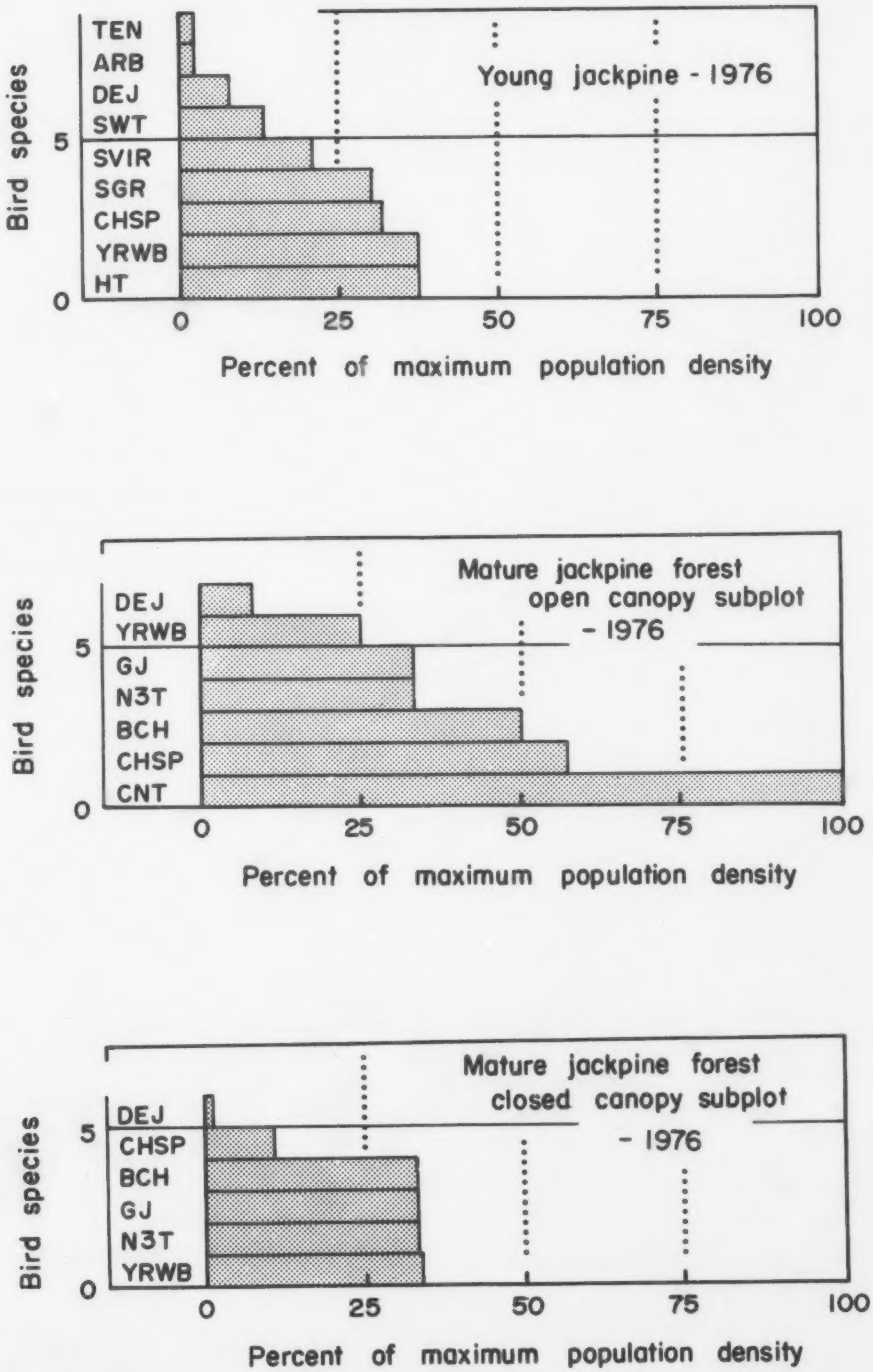


Figure 9. Species/habitat saturation histograms for jack pine forest plots and subplots.

4.4.3.4.3 Mixed Forests:

Text References

Plot	Plot density data	Subplot density data	Habitat Description
Mature Mixed forest plot	Table 27	Table 44	P. 288
Young Mixed forest plot	Table 26	Table 45	P. 289
Aspen Pine Plot	Table 23	None	P. 282

The evaluation of mixed forest as breeding bird habitat requires an understanding of the effects of several variables: in the tree canopy--height, density, height diversity and species composition; in Stratum 2--density, species composition and height diversity. Comparison and subplot analysis demonstrated the effects of these variables.

The species richness (23) and C.I.N. (13) figures were relatively high for the aspen-pine plot, whereas the total population (207 territories per 100 ha) was rather low. The species/habitat saturation histogram (Figures 10, 11 and 12) suggests that the aspen-pine plot was suitable habitat for many species but excellent for none. The tree canopy on this plot was fairly diverse in height, and had many small openings. Thus the tree canopy provided both foliage height diversity and horizontal foliage/space diversity. The shrublayer consisted almost entirely of 2 m tall alder and varied between open and closed. This provided some horizontal foliage/space diversity in the open areas, but little height diversity or foliage height diversity. The gap between shrub and tree foliage rarely exceeded 5 m and was generally much less.

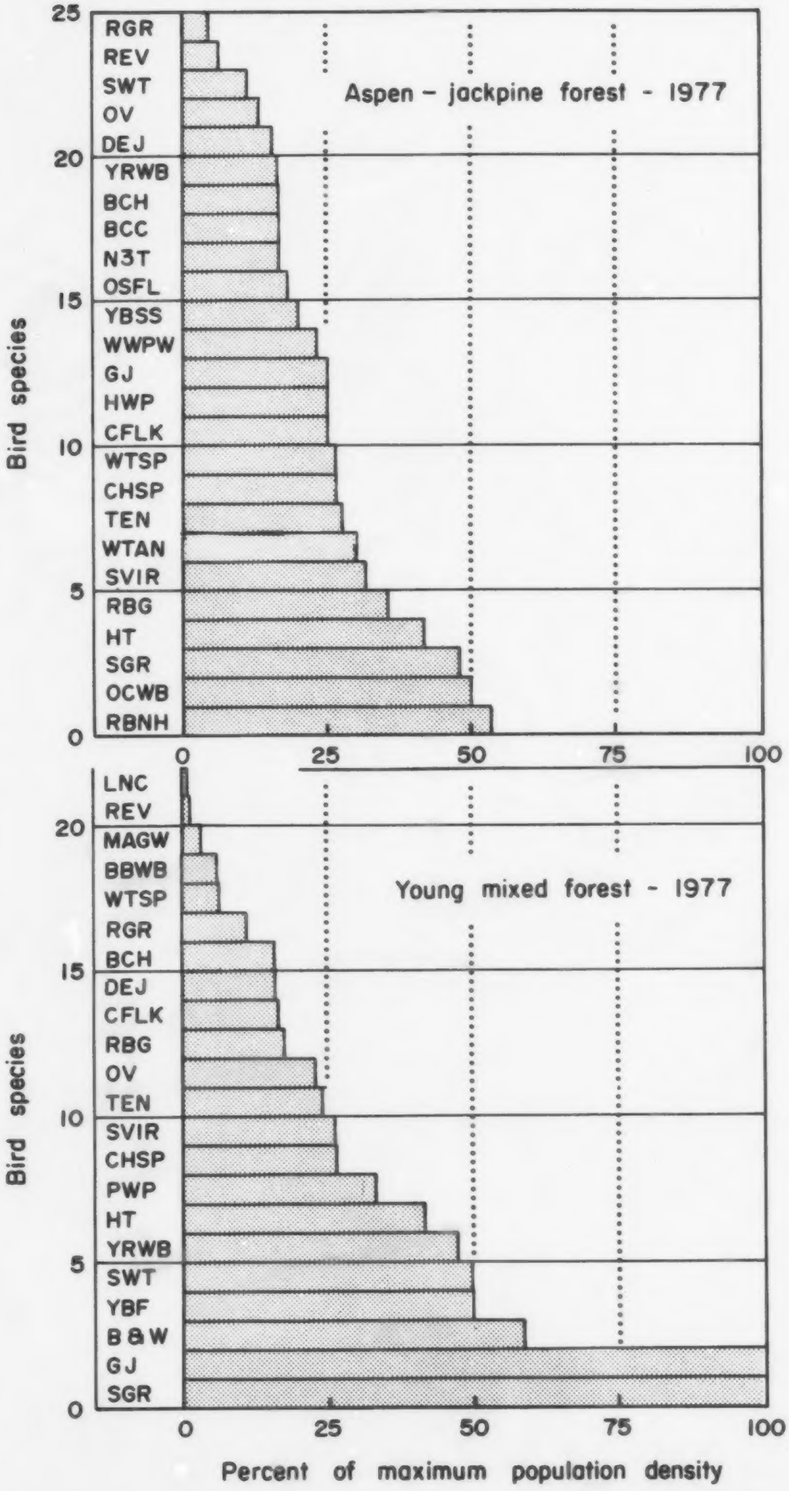


Figure 10. Species/habitat saturation histograms for the aspen-jack pine and young mixed forests.

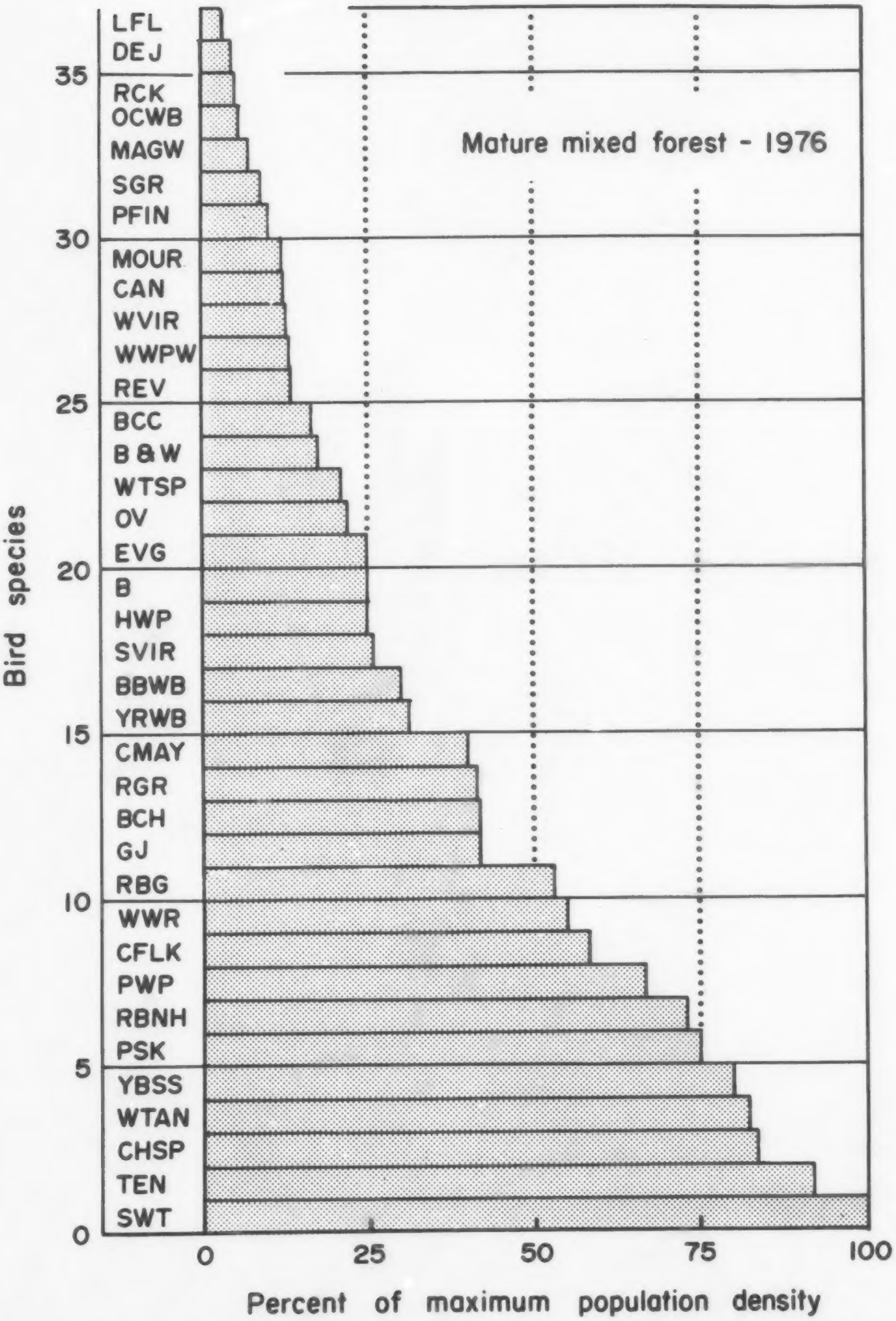


Figure 11. Species/habitat saturation histograms for the mature mixed forest.

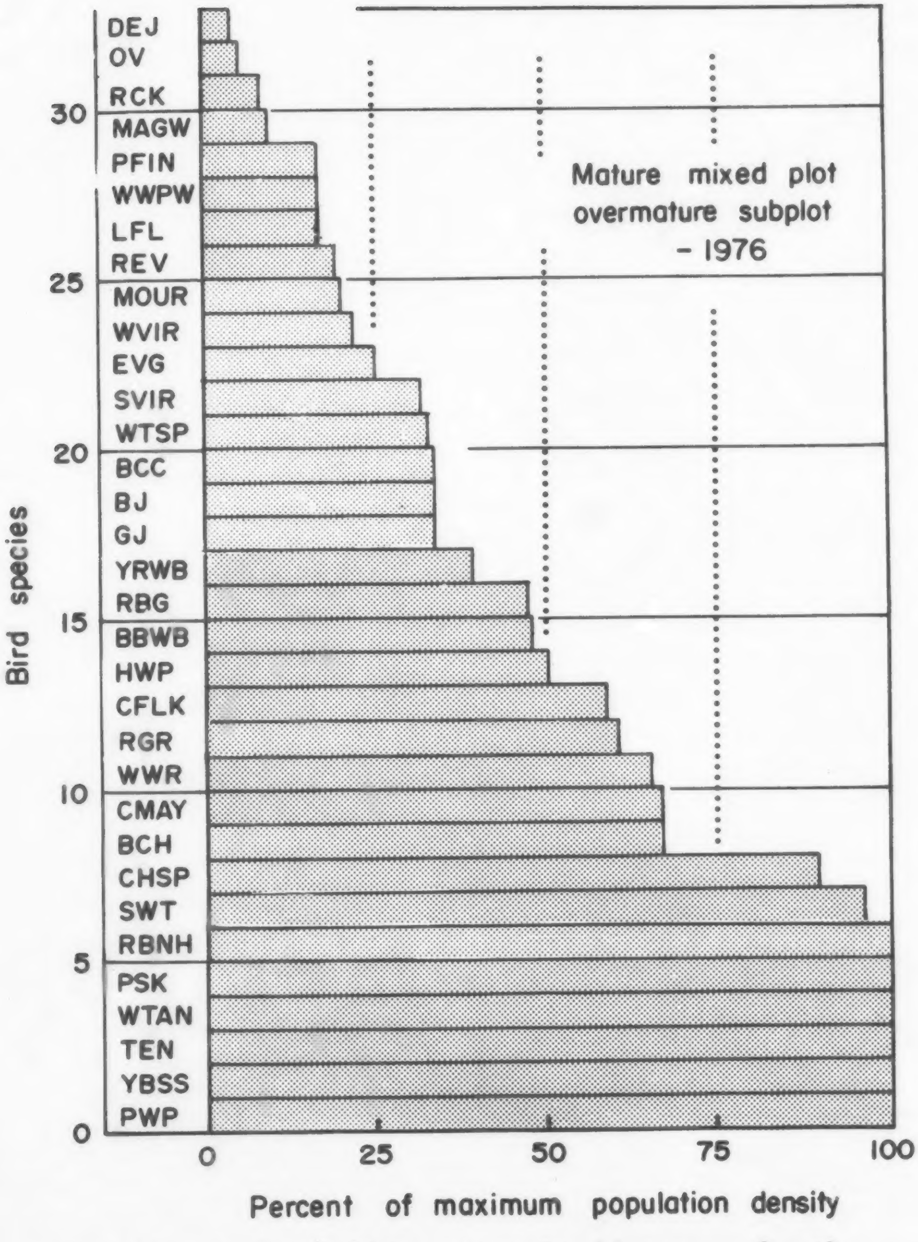


Figure 12. Species/habitat saturation histograms for the overmature subplot of the mature mixed forest plot.

It seems likely that the "shape" of the habitat (the height diversity and openings in the tree canopy combined with adequate density and height in the shrublayer) resulted in a variety of species niches. The relatively low populations of many shrublayer and lower-tree-canopy oriented species (e.g., Black-capped Chickadee, Swainson's Thrush, Tennessee Warbler, and Rose-breasted Grosbeak) were probably attributable to several factors:

1. Lack of height diversity and foliage height diversity in the shrublayer;
2. Dominance of alder in the shrublayer;
3. Dominance of jack pine in the tree stratum; and
4. Absence of deciduous foliage in the gap between the top of the deciduous shrubs and the bottom of the aspen tree foliage. The presence of scattered to open pine foliage in this gap apparently did little to increase the suitability of the habitat for deciduous-oriented bird species.

The young mixed forest plot was divided into four subplots. One of these (Subplot 4), consisted of a strip of willow bog and a 50 m swath of forest on either side of it. This subplot will be discussed in the habitat mixtures section. The other three subplots isolated examples of particular variations in Stratum 2.

The tree canopy on these subplots was fairly uniform, consisting of dense-to-closed pine-aspen-black spruce forest. Tree height was fairly uniform within each 50 x 50 m block, although stand height varied from 8 to 13 m over the plot. Foliage height diversity, height diversity, and horizontal foliage/space diversity were all minimal in the tree canopy.

Subplot 1 was characterized by a scattered to open shrublayer of 2 m tall willow. Individual willow clumps were small and sparsely foliated; thus, even though the spacing of clumps was correct for relatively high foliage/space diversity, the positive effects were mitigated by the lack of willow foliage. This subplot had a low total population but seemed to be preferred habitat for a few species, most notably the Hermit Thrush.

Subplot 2 was characterized by a dense to closed shrublayer, dominated by 1.5 to 2 m tall alder. This shrublayer provided little height diversity and little foliage height diversity.

Horizontal foliage/space diversity in Stratum 2 was limited by the high plant density. A foliage gap of up to 6 m was present between shrub and tree foliage. It seems likely that all of these factors contributed to limiting suitability of this habitat; this subplot also supported a low total population.

On Subplot 3, Stratum 2 was dense and dominated by black spruce. Some deciduous shrubs, primarily 1.5 to 3 m tall willow, were invariably present. The black spruce in this subplot displayed considerable height diversity; some were less than 1 m tall, others reached to the base of the tree canopy of pine and aspen.

This subplot supported a more abundant and slightly more diverse breeding avifauna than did the above-mentioned subplots, and appears to have been preferred habitat for Swainson's Thrush and Yellow-rumped and Black-and-white Warblers. However, the overall abundance and diversity of breeding avifauna on this subplot were still relatively low compared to some other habitats. Horizontal foliage/space diversity and height diversity were considerable in the shrublayer, and foliage height diversity was considerable; at least scattered foliage was present at all levels from ground to treetops. Yet some limiting factor is clearly present.

Probable limiting factors are:

1. Lack of height diversity and horizontal foliage/space diversity in the tree stratum.
2. Dominance in the tree stratum of jack pine.
3. Absence of deciduous foliage in the gap between the top of the deciduous shrubs (3 m) and the bottom of the deciduous trees (around 8 to 9 m). The black spruce foliage present in that gap was clearly adequate for Swainson's Thrush and Black-and-white Warbler, but was

probably limiting for Rose-breasted Grosbeak. This gap in the deciduous foliage possibly accounted for the absence of Black-capped Chickadee and Least Flycatcher from the plot.

4. The very low open ground cover probably limited the suitability of this subplot for Ovenbirds and Hermit Thrushes.

The mature mixed forest plot split neatly into two subplots. The mature mixed forest subplot was a spruce-aspen-pine forest in which the canopy was generally closed or dense. Tree heights varied by up to 3 or 4 m within most 50 x 50 m blocks, and stand height varied from 12 to 18 m over the subplot. This provided some horizontal foliage/space diversity at the top of the tree canopy. Stratum 2 was generally dense and consisted mainly of white spruce, willow and alder. Foliage height diversity was considerable in the spruce-dominated areas, but less so in the aspen- and pine-dominated areas. No deciduous foliage was present between the top of the deciduous shrubs and the bottom of the aspen trees, although spruce foliage frequently was present in this gap.

The bird population found on this subplot was somewhat higher in both abundance and diversity than that of Subplot 3 of the young mixed forest plot.

Four species (Yellow-bellied Sapsucker, Western Tanager, Chipping Sparrow and Tennessee Warbler) bred at much higher densities on the mature mixed forest subplot. The first two are characteristic of mature forests and were not present on the young mixed forest plot. The latter pair are both associated with horizontal foliage/space diversity in the tree stratum. One species, the Yellow-rumped Warbler, apparently preferred the denser tree canopy of the young mixed forest subplot.

The overmature mixed forest subplot was a spruce-aspen-pine-birch stand in which the tree canopy was generally dense. Height diversity in the tree canopy was considerable; tree height varied from 5 to over 30 m within most 50 x 50 m blocks. Stratum 2 was generally dense, and consisted of white spruce, alder and willow. Both deciduous and coniferous foliage were present at all height levels between the ground and 30 m above ground. Foliage height diversity, deciduous and coniferous, horizontal foliage/space diversity at all height levels, and height diversity were all greater on this subplot than on any of the other studied habitats. Predictably, this was the best breeding bird habitat of all those we sampled. Two other factors probably contributed to the abundance and diversity of breeding avifauna:

1. The spruce trees were frequently clumped, forming very dense copses. These probably increased the suitability of the habitat for Yellow-rumped, Cape May and Bay-breasted Warblers, and Winter Wrens.
2. The presence of four species of woodpeckers and three species of secondary hole nesters (the two chickadees and Red-breasted Nuthatch) are probably attributable to the presence of overmature and standing dead trees.

Summary:

Mixed forests do not necessarily support a diverse or abundant breeding bird population, although certain types of mixed forest are probably the most densely and diversely populated habitats in the study area. A dense spruce-dominated understory with considerable height diversity is preferred by most species to an open or alder-dominated understory. An open, mixed-age stand, with considerable height diversity and horizontal foliage/space diversity in the tree canopy, is probably preferred by most species to any other mixed forest canopy. Foliage height diversity must be considered in two categories: deciduous and coniferous. A habitat which provides both deciduous and coniferous foliage at all height levels will be suitable for both deciduous and coniferous oriented species. Horizontal foliage/space diversity is important in Strata 2 and 3. Clumping of spruce trees and presence of overmature or standing dead trees increase habitat suitability for some species.

4.4.3.4.4 Coniferous Muskeg

Text Reference

Plot	Plot density data	Subplot data	Habitat Description
Young black spruce plot	Table 37	Table 49	P. 311
Mature black black spruce plot	Table 38	None	P. 313

The young black spruce and mature black spruce plots were chosen in order to assess the value of black spruce to breeding avifauna. Particular attention was paid to the effects on abundance and diversity of breeding avifauna of three variations in black spruce habitats: height and density of black spruce, and presence of deciduous foliage in Strata 2 and 3.

The species richness figure for the young black spruce plot (Table 37) is a poor measure of the diversity of avifauna to be expected in a pure stand of young black spruce. The plot contained many "impurities", such as a small area with a canopy of pine and aspen trees. Willow shrubs and tall dead spars were present over much of the plot. At least seven species (Greater Yellowlegs, Common Flicker, Solitary Vireo, Black-and-white Warbler, Tennessee Warbler, Blackpoll Warbler and Lincoln's Sparrow) were associated with these "impurities". The C.I.N. gives a more accurate measure of the diversity of breeding avifauna associated with the young black spruce. The similarity between species richness and C.I.N. figures on the mature black spruce plot reflects the homogeneity and "purity" of the stand and the concomitant sparsity of "incidental" niches.

f2

Table 11 presents the total population, species richness and C.I.N. figures for the young black spruce and mature black spruce plots.

It would appear that, while the two habitats supported similar total populations, the mature stand contained a greater diversity of integral niches. The species/habitat saturation histograms (Figure 13) suggest that the mature stand was preferred habitat for at least seven species. The presence of three species of woodpeckers on the mature black spruce plot was probably attributable to the maturity and height of the stand. Considerable foliage height diversity was present in both stands, although the foliage height diversity in the mature stand was a function not of variations in tree height (which was fairly uniform) but rather of the depth of foliage on each tree. On a typical tree 14 m tall, the canopy foliage extended down to about 3 m above the ground in open stands and down to about 7 m above the ground in dense to closed stands.

The subplot data from the young black spruce plot provided excellent information on the habitat preferences of individual species (see Appendix 7.1), but provided few indications of preferences common to a majority of species. This was further complicated by the fact that there was quite a bit of overlap among subplots (#1 included most of #4 and #6; #3 included parts of #5 and #6), and by the fact that the total density figures were strongly influenced by the relative abundance of Palm Warblers. Two general principles were inferred from this subplot analysis: that bird species diversity increases with increasing presence of a deciduous element, and that a black spruce stand under 2 m tall is less attractive to most species than a taller stand.

On the mature spruce plot, as on the mature jack pine plot, foliage height diversity in the tree canopy and, by definition, horizontal foliage/space diversity were greater in open stands than in denser stands. While the individual stands on the mature black

Table 11. Total population, species richness and C.I.N. for young black spruce and mature black spruce plots.

Plot	Total Pop'n.	Species Richness	C.I.N.
Young Black Spruce	233	20	6
Mature Black Spruce	203	14	11

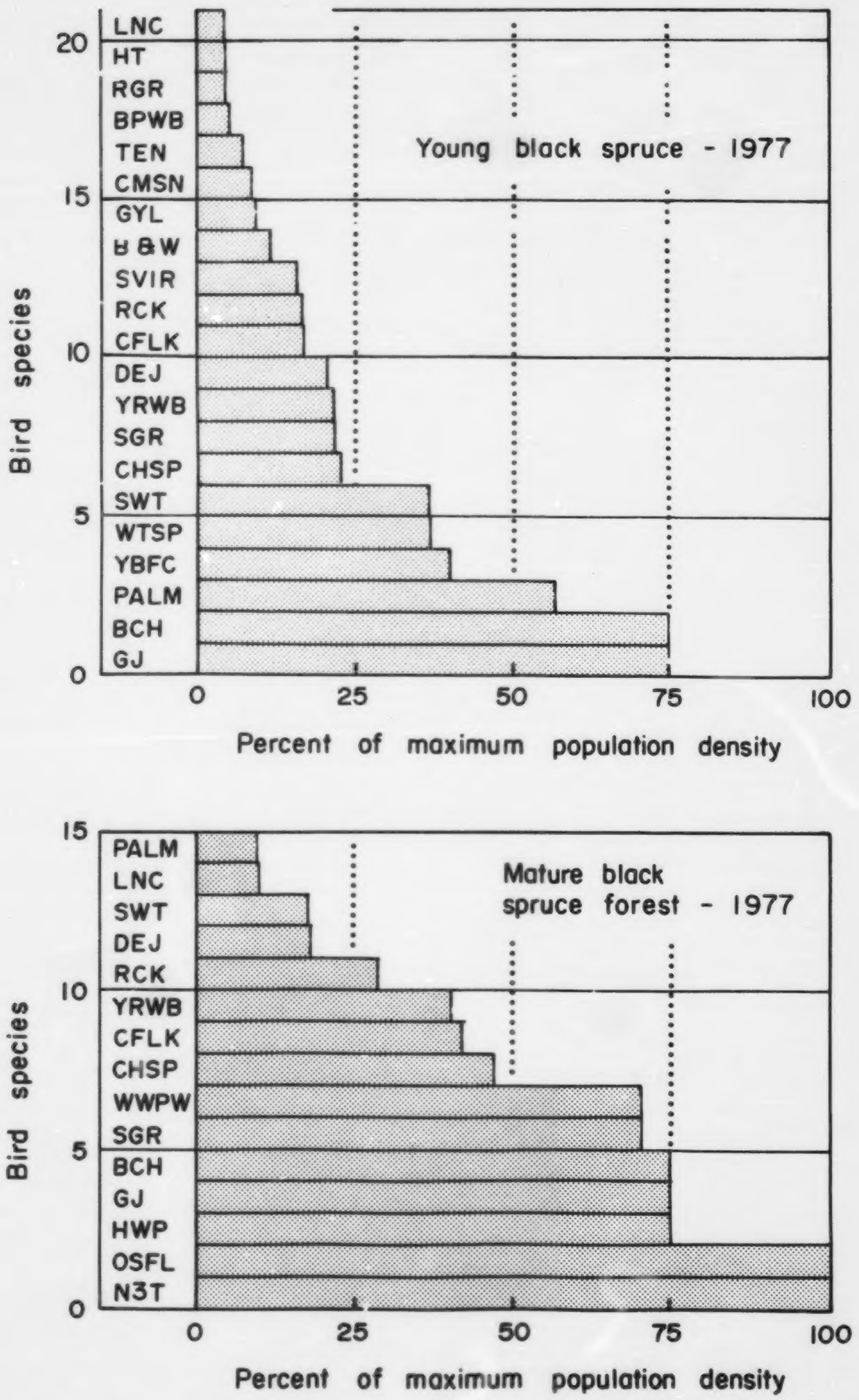


Figure 13. Species/habitat saturation histograms for the young and mature black spruce plots.

spruce plot were too small to permit subplot analysis, certain patterns were evident. At least two species (Chipping Sparrow and Western Wood Pewee) were strongly associated with the more open stands.

Summary:

While black spruce stands do not support high total populations, the more mature stands can support a fairly high diversity. In young stands, diversity increases with the presence of some deciduous foliage; this principle probably applies in mature stands also. As a general rule, diversity tends to increase with increasing stand height.

4.4.3.4.5 Mixed and Deciduous Muskegs and Fens

Text References

Plot	Plot density data	Subplot data	Habitat Description
Bitumount muskeg plot	Table 39	Table 50	P. 314
Open bog plot	Table 35	None	P. 308
Deciduous shrub fen plot	Table 34	Table 47	P. 308
Sedge fen plot	Table 36	None	P. 310
Tamarack muskeg plot	Table 40	Table 48	P. 315

The evaluation of mixed and deciduous muskegs and fens as breeding bird habitat required the assessment of the effects of several variables: the presence and height of conifers; and the height, density and species composition of both Stratum 2 (shrublayer) and Stratum 1 (ground cover).

The simplest habitat we studied was the sedge fen plot, a wet meadow with a closed layer of 0.5 m tall sedges with scattered clumps of 2 to 4 m tall willows around the edge.

The species/habitat saturation histogram (Figure 14) for this plot reveals that, while the plot supported a low bird diversity, it did support very high density of five species. Three other species (essentially Stratum 2 oriented) are present in lesser numbers.

The open bog plot sampled a habitat not much more complex than the sedge fen. The open bog plot was dominated by 0.75 m tall swamp birch. The species/habitat saturation histogram (Figure 14) for this plot reveals a population structure very similar to that of the sedge fen. It should be noted that four of the species present on the open bog plot (Gray Jay, Common Flicker, Palm Warbler and Chipping Sparrow), while they utilize the plot for feeding and/or territorial display, were mainly associated with the adjacent woodlands, and would not have been present on a more extensive open bog.

The deciduous shrub fen plot included substantial areas of willow fen and swamp birch fen, plus a small incursion of young black spruce muskeg.

The swamp birch fen subplot was characterized by a dense shrublayer of 1.5 m tall swamp birch. The foliage clumping typical of swamp birch in this height range provided good cover, thus horizontal foliage/space diversity was considerable. The relatively low diversity of breeding avifauna on this subplot suggests that swamp birch is unattractive to some bird species (e.g., Alder Flycatcher and Wilson's Warbler).

The willow fen subplot was characterized by closed willow 2 to 2.5 m tall. Horizontal foliage/space diversity was minimal as there was no space between clumps. The diversity of breeding avifauna

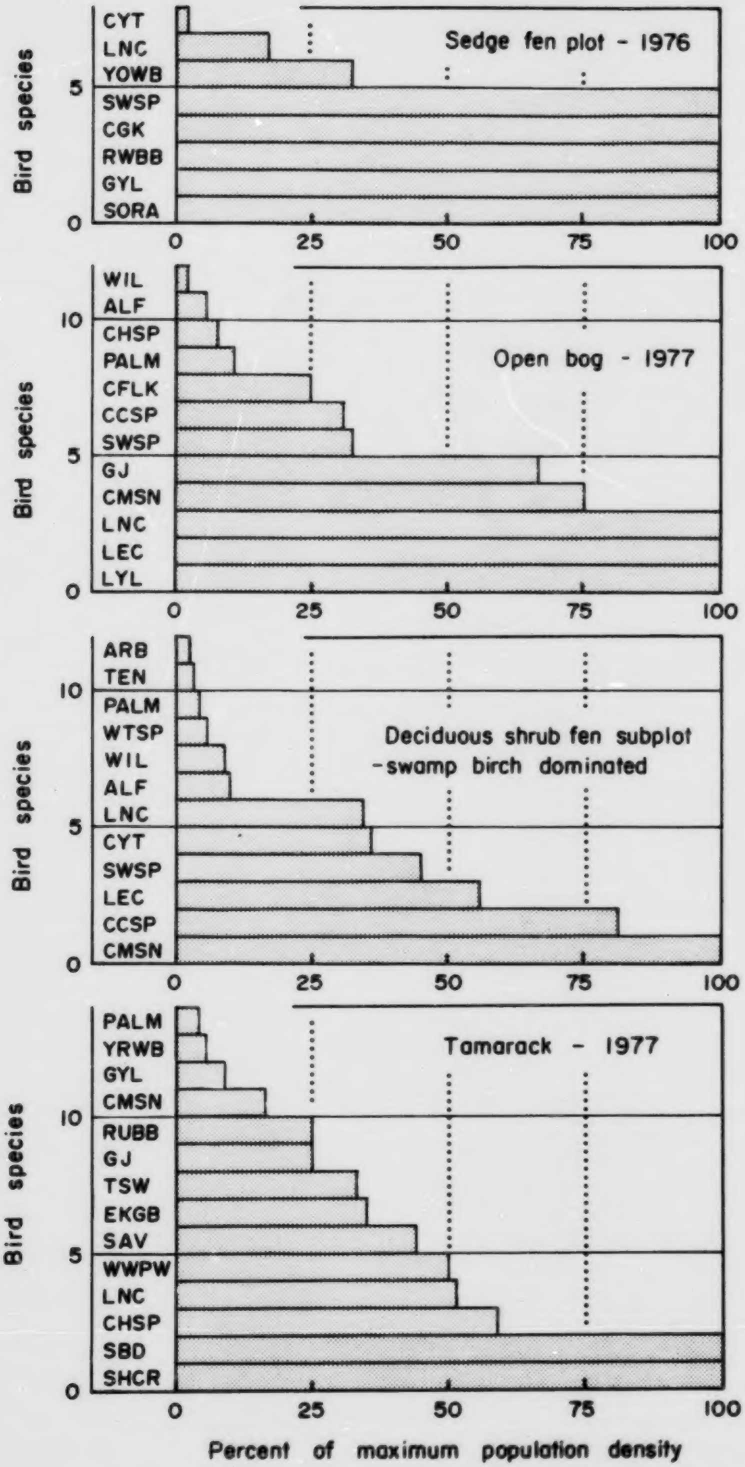


Figure 14. Species/habitat saturation histograms for the sedge fen, open bog, deciduous shrub fen subplot and the tamarack plot.

on this subplot [data presented in tabular form (Table 47) only due to small size of subplot] was also low. The absence of horizontal foliage/space diversity probably limited the populations of Gennessee Warblers, American Redstarts, and White-throated and Lincoln's sparrows.

Three species (Alder Flycatcher, Wilson's Warbler and Swamp Sparrow) showed a distinct preference for the willow subplot over the swamp birch subplot. This probably reflects a preference for willow by these species, although it may also reflect a preference for slightly taller shrubs.

The tamarack muskeg plot sampled a somewhat more complex habitat: in addition to the open layer of 1 m tall swamp birch, there was a scattered layer of mature stunted tamarack (2 to 5 m tall). The species/habitat saturation histogram (Figure 14) and the C.I.N. (10) for this plot indicate a moderately high diversity in this habitat. The presence of several tree-oriented species (Chipping Sparrow, Western Wood Pewee, Gray Jay, Yellow-rumped Warbler) suggests that the presence of the scattered tamaracks considerably increases the value of a swamp birch-dominated habitat.

Subplot analysis of the tamarack muskeg plot tested four variations:

1. Tamarack averaging 5 m or taller;
2. Tamarack mostly open as opposed to scattered;
3. Swamp birch dense as opposed to open; and
4. Swamp birch 1.5 m (as opposed to 1 m or less) tall and clumped.

Population data from the first three subplots were identical to population data for the whole plot; i.e., the variations they sampled had no apparent significance. Data from the fourth subplot are presented in Table 48. The apparent positive response by tree-oriented species to increased shrublayer height is difficult to explain, but probably stemmed in some way from the physiognomy of the 1.5 m tall swamp birch. A typical clump of 0.75 m tall swamp birch provides little cover; the individual stems are quite discrete. At 1.5 m in height, swamp birch typically forms a clump of dense foliage, providing considerably increased horizontal foliage (i.e., cover) space diversity. (The swamp birch clumps may have been used for nesting. Foliage, and hence cover, was sparse on the tamaracks.) The apparent lack of response to increasing density of a uniformly short shrublayer was also noted in the McClelland Lake aspen forest plot. The tamarack trees were invariably taller than the swamp birch and were utilized by several species as singing and/or hawking perches.

The data suggest that a slight increase in height or density of a stunted tamarack layer does not increase the value of the habitat; further increase (e.g., to beyond 8 m) might have some positive effect.

The Bitumount muskeg plot sampled a muskeg type which was complex in two senses: the plot sampled a combination of several different habitat types, and each of the component "types" was fairly complex in itself.

The Bitumount muskeg plot consisted of:

1. A stand of 4 to 8 m tall black spruce (for discussion see Section 4.4.3.4.7.
2. An area of open to dense canopied tamarack fen. The tamarack averaged 10 m in height, and a dense understory of 1.5 m tall swamp birch was present beneath.
3. An area of open to closed deciduous shrub-dominated scrubland. Willows 1.5 to 4.5 m tall were the dominant species, although 2 to 4 m tall black spruce, 1 m tall swamp birch and 0.75 m tall shrub cinquefoil were also present.
4. A band 100 to 250 m wide, in which the willow was 2.5 to 4.5 m tall. (This overlapped slightly with the willow scrub subplot.) A scattered-clumped tree canopy (combinations of black and white spruce, balsam poplar, trembling aspen and jack pine) was present above the willow over much of this subplot. The tree canopy, when present, exhibited considerable height and foliage height diversity.

The tamarack subplot was attractive habitat for at least five species (Sandhill Crane, Common Snipe, Greater Yellowlegs, Lincoln's and Swamp Sparrows). The small size of the subplot renders unclear its attractiveness to other species (e.g., Chipping, LeConte's and Sharp-tailed Sparrows, Yellow-rumped Warbler, Gray Jay and Purple Finch).

The willow scrub subplot provided considerable horizontal foliage/space diversity. This habitat seems to have been attractive for at least 6 bird species (Alder Flycatcher, Tennessee and Wilson's Warblers, Clay-coloured, White-throated and Lincoln's Sparrows). Population fluctuations and the small size of the subplot render unclear its attractiveness to other species (e.g., Gray Jay, Orange-crowned Warbler, Chipping Sparrow, Swainson's Thrush).

The "tall willow with scattered trees" subplot of the Bitumount muskeg plot was the most complex of the water-saturated habitats we studied. It was an amalgam of short and tall (tall dominating) willow, other shrubs, short and tall conifers, and tall deciduous trees. This subplot appears to have been preferred habitat for two species (Tennessee Warbler and White-throated Sparrow), and suitable habitat for more than a dozen other species. This habitat supported the most diverse avifaunal community of any of the water saturated habitats we studied.

Foliage Height Diversity:

It appears that simple shrub habitats, those in which only one species of woody stemmed plant is present in significant amounts, support very few species of breeding avifauna (Figure 15). In such habitats, the abundance of avifauna seems to increase with an increase in the height of the shrubs, but the diversity is probably more affected by horizontal foliage/space diversity. Diversity probably does increase somewhat in very tall shrub habitats (i.e., those in which shrubs are over 5 m tall).

The addition of a coniferous element to a deciduous-dominated habitat (e.g., the tamarack bog plot) appears to result

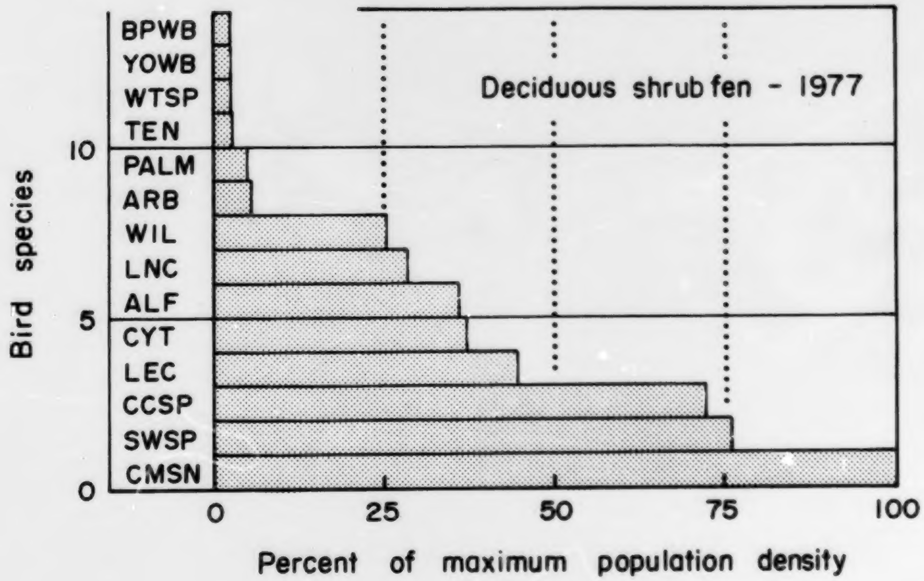


Figure 15. Species/habitat saturation histograms for deciduous shrub fen.

in an increase in avifaunal diversity, even when the foliage height diversity does not extend much beyond 3 m above ground. This would suggest that foliage height diversity does not explain this increase in bird diversity. Two alternate explanations seem more likely:

1. That the increasing plant species complexity has some effect; and
2. That plant height diversity, by providing exposed perches for singing and hawking has an effect (i.e., horizontal foliage/space diversity).

The "tall willow with some trees" subplot of the Bitumount muskeg plot provided both foliage height diversity and plant height diversity. The fact that shrub foliage extended right up to 5 m, the presence of clumps of tree canopy, and the fact that both deciduous and coniferous foliage were present at all height levels are suggested to have contributed to the diversity and abundance of avifauna this habitat supported (Figures 16 and 17).

Summary:

Certain highly complex, water-saturated habitats can support a diverse and abundant breeding avifauna. The simpler habitats tend to support low diversity and variable abundance of breeding avifauna. Population levels (but not diversity) seem to be generally higher in fens than in bogs (Table 12). Mixtures of short coniferous trees and deciduous shrubs seem to support a higher diversity (but not necessarily a greater abundance) of avifauna than do shrub-only habitats. Open and dense shrublayers appear to be equally acceptable to most bird species. Horizontal foliage/space diversity may increase attractiveness for some bird species; the attractiveness of closed shrublayers to these species is low. In habitats less than 3 m tall, abundance of breeding avifauna seems to increase with shrub height, but diversity seems more a function of horizontal foliage/space diversity. Increasing height of shrubs above 5 m increases diversity. Most species prefer willow to swamp birch. Presence of tall trees increases diversity of breeding avifauna which were highest in a habitat that provided both deciduous and coniferous foliage at all heights.

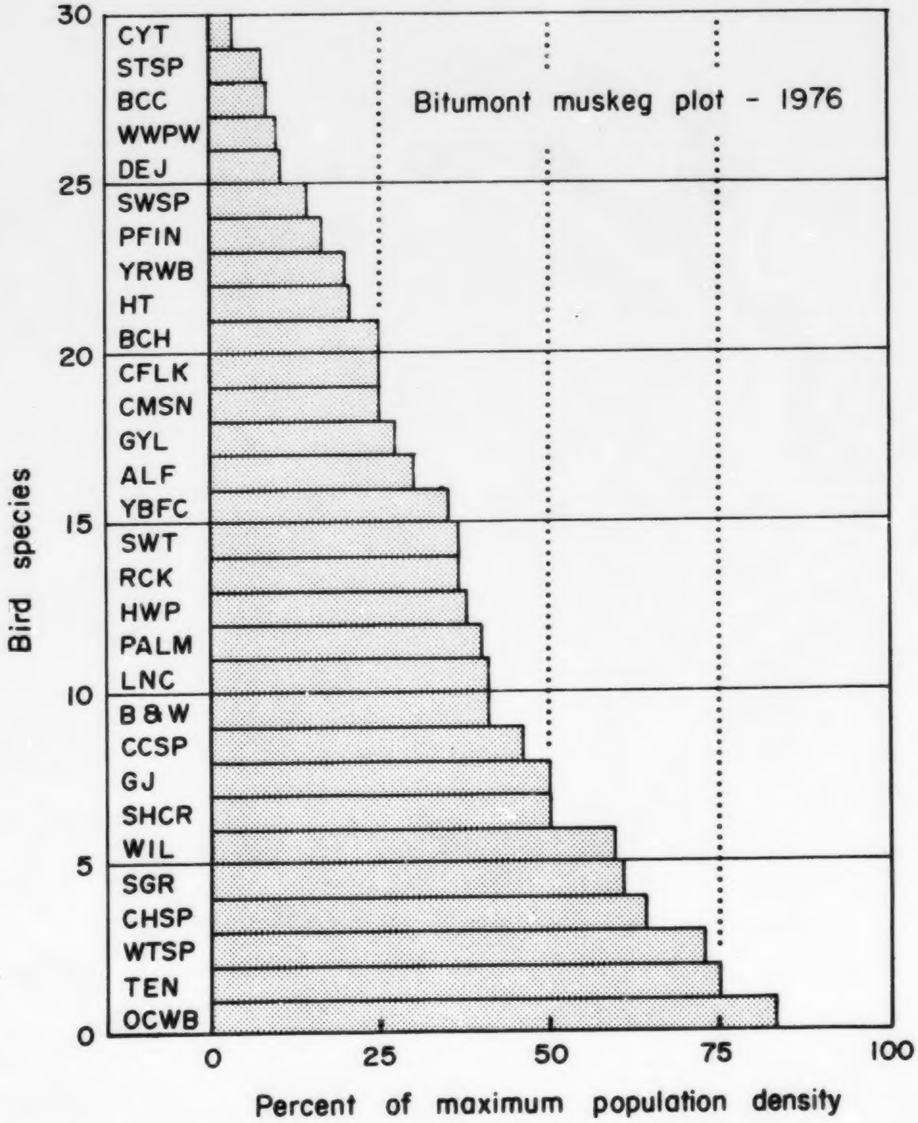


Figure 16. Species/habitat saturation histograms for the Bitumount muskeg plot, 1976.

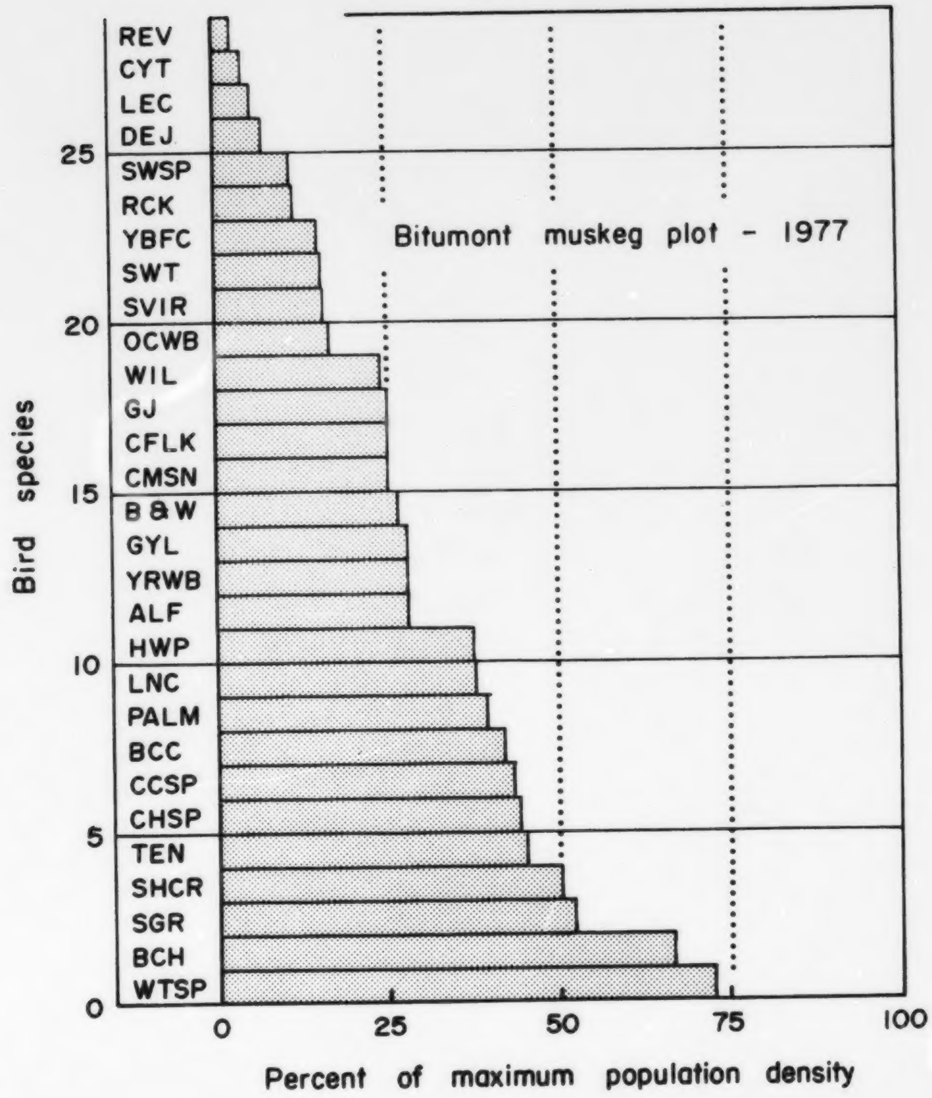


Figure 17. Species/habitat saturation histograms for the Bitumount muskeg plot, 1977.

Table 12. Total population, species richness, C.I.N. values and habitat parameters for mixed and deciduous muskeg and fen plots and subplots.

Plot	Strata 2 & 3 Dominant Species	Bird Pop'n	Species Richness	C.I.N.
Open Bog	Swamp Birch (0.75 m)	276	12	3
Deciduous Shrub Fen: Willow Sub-Plot	Willow (2 m)	583	11	approx. 6
Deciduous Shrub Fen Swamp Birch Subplot	Swamp Birch (1.5 m)	307	12	6
Sedge Fen	Willow (2-4 m)	479	8	6
Tamarack Muskeg	Swamp Birch (1 m) Tamarack (3 m)	176	15	10
Tamarack Muskeg Subplot	Swamp Birch (1.5 m) Tamarack (3 m)	195+	N/A	N/A
Tamarack Fen (Bitumount Muskeg-1977)	Tamarack (10 m) Swamp Birch (1.5 m)	308	11	N/A
Willow Scrub (Bog and Fen) (Bitumount Muskeg-1977)	Willow (1.5 to 4.5 m)	463	16	N/A
Tall Willow with some trees (Bog and Fen) (Bitumount Muskeg-1977)	Willow (2.5 to 4.5 m) plus various trees (variable heights)	491	25	approx. 16

The river valley mixed forest strip plot sampled a forest similar to that of the "12 to 18 m tall mixed forest" subplot of the mature mixed forest plot. The main differences were that the river valley mixed forest plot incorporated 2.1 km of forest-river interface and lacked jack pine trees.

The river valley mixed forest supported a more abundant and more diverse population of breeding birds than did the 12 to 18 m tall mixed forest. However, the deletion from the plot density data of those species associated with river edge and "stand impurities" (an abandoned trapper's cabin in a large clearing) revealed remarkably similar populations in the two forests. Table 13 presents the density data for the mixed forest subplot, the complete river valley mixed forest plot and the river valley mixed forest plot minus eight interface-associated species (Spotted Sandpiper, Eastern Phoebe, Yellow Warbler, Northern Waterthrush, Mourning Warbler, American Redstart, Lincoln's Sparrow, and Song Sparrow).

The substantial increase in diversity and abundance which occurs along a river/forest interface will therefore considerably increase the value of any river valley mixed forest.

4.4.3.4.6 Riparian Habitats

Text Reference

Plot	Plot density data	Subplot data	Habitat Description
River Valley mixed forest plot	Table 28 Figure 18	None	P. 295
Mature bottomland willow plot	Table 31 Figure 19	None	P. 298

Table 13. Comparison of river valley and upland mixed forests.

Plot	Total Population	Species Richness	C.I.N. (values approx.)
12 to 18 m tall mature mixed forest subplot (mature mixed forest plot)	354	20	12
River valley mixed forest plot minus interface-associated species	365	26	13
River valley mixed forest plot complete population	430	34	15

Text Reference (Continued)

Plot	Plot density data	Subplot data	Habitat Description
LaFont Island	Table 29 Figure 20	Table 46	P. 296
Mature bottomland balsam poplar/ scrub willow plot	Table 30 Figure 20	Table 16	P. 293
Hartley Creek Valley Plot	Table 32 Figure 21	None	P. 300

The evaluation of riparian habitats as breeding bird habitat represents a fairly complex problem. The value of a particular study plot is not difficult to assess, but it is also important to assess the relative values of the habitat itself and the interfaces present. This has been done for most habitats, but in some cases it is not possible. The value of the forest will decrease (all other factors being equal) as the distance from the interface increases.

The mature bottomland willow plot was sampled for several reasons. The authors wanted to establish not only the value of a typical stand of mature willow bottomland, including river and oxbows, but also the relative values of mature willow and willow/water interfaces.

The mature willow, in combination with the river and oxbows, supported the most abundant and diverse breeding avifauna of our 1977 study plots (Figure 19). The total population in this habitat might well have exceeded 600 territories per 100 ha in 1976. The plot included 2.1 km of the Muskeg River and 1.5 km of oxbows.

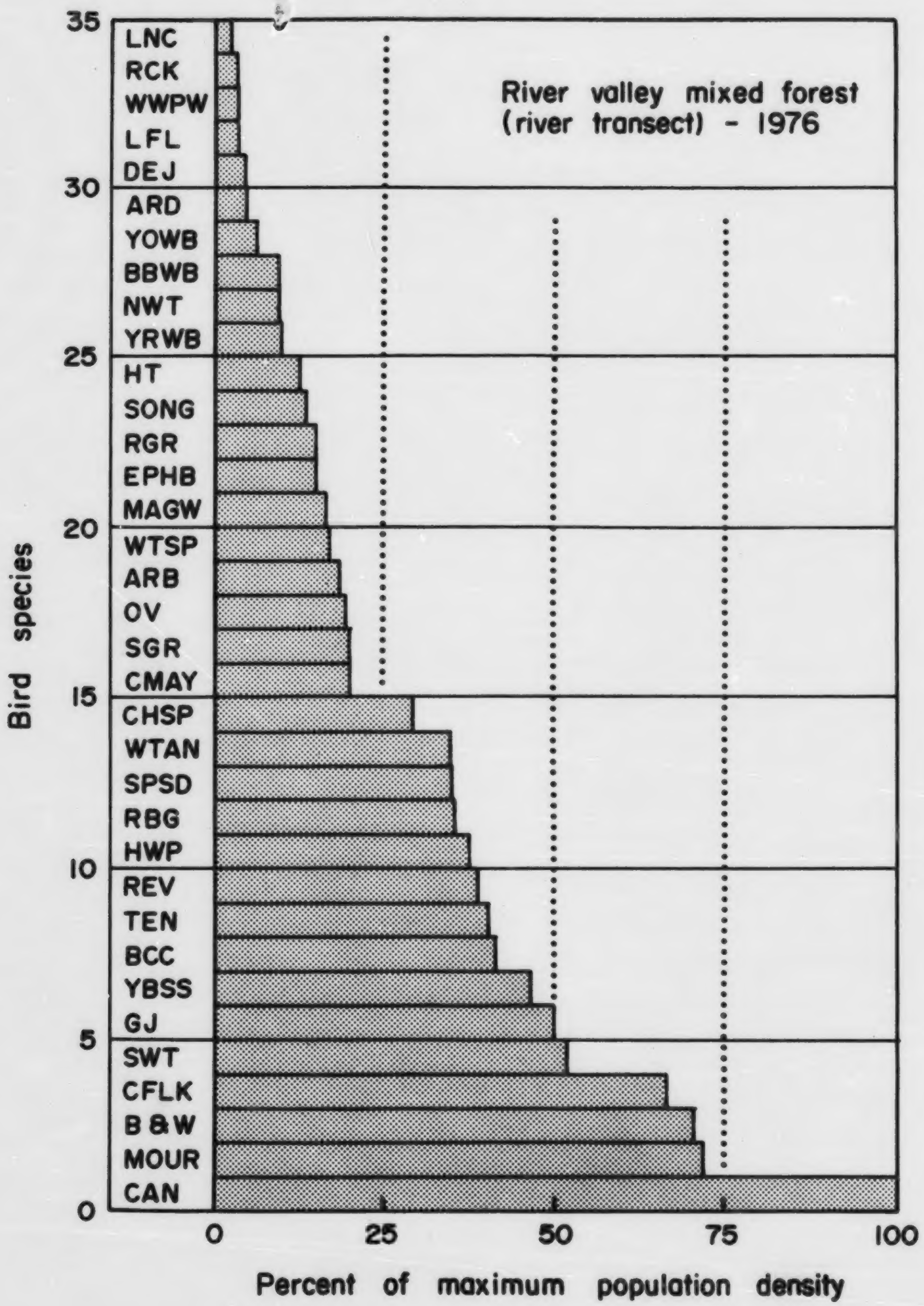


Figure 18. Species/habitat saturation histograms for the river valley mixed forest.

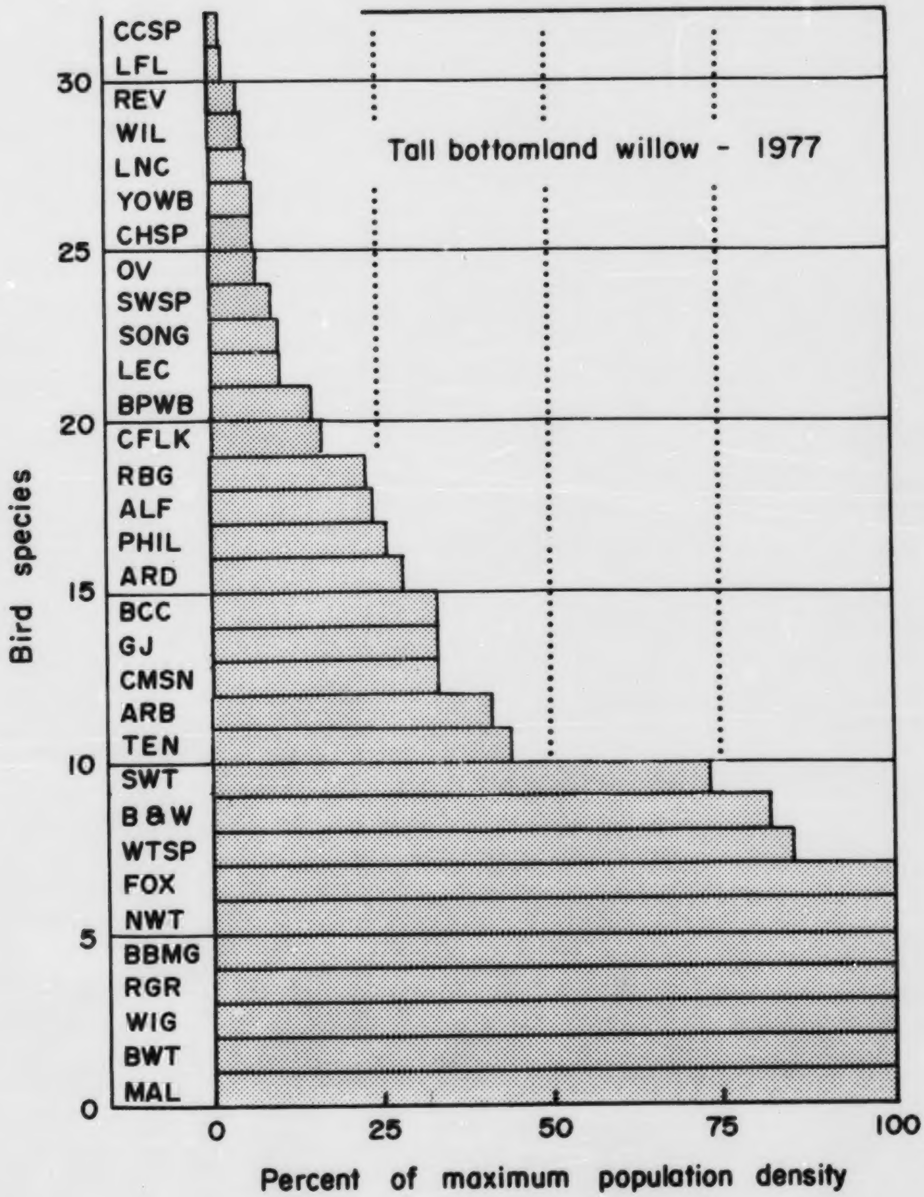
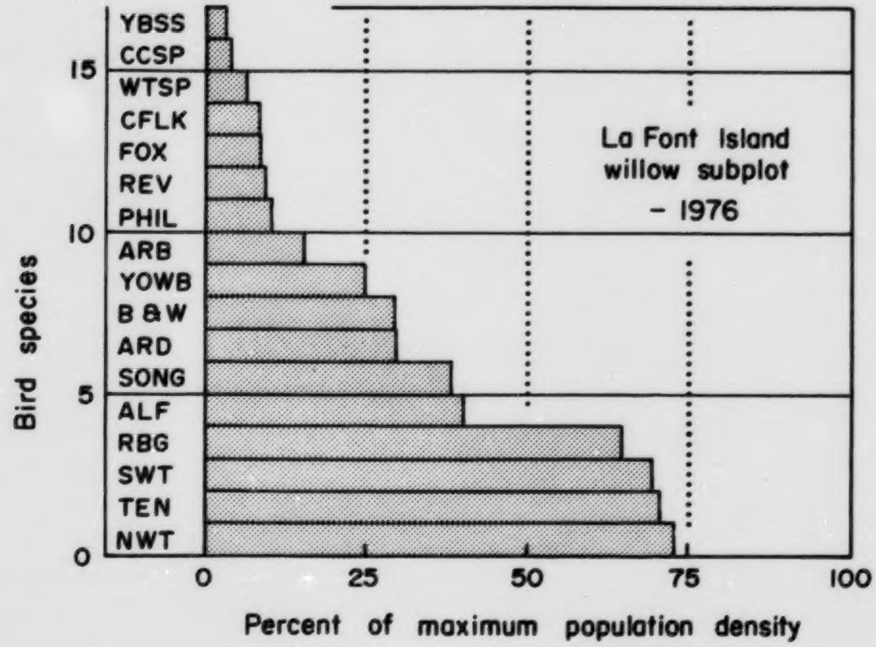


Figure 19. Species/habitat saturation histograms for the tall bottomland willow plot.



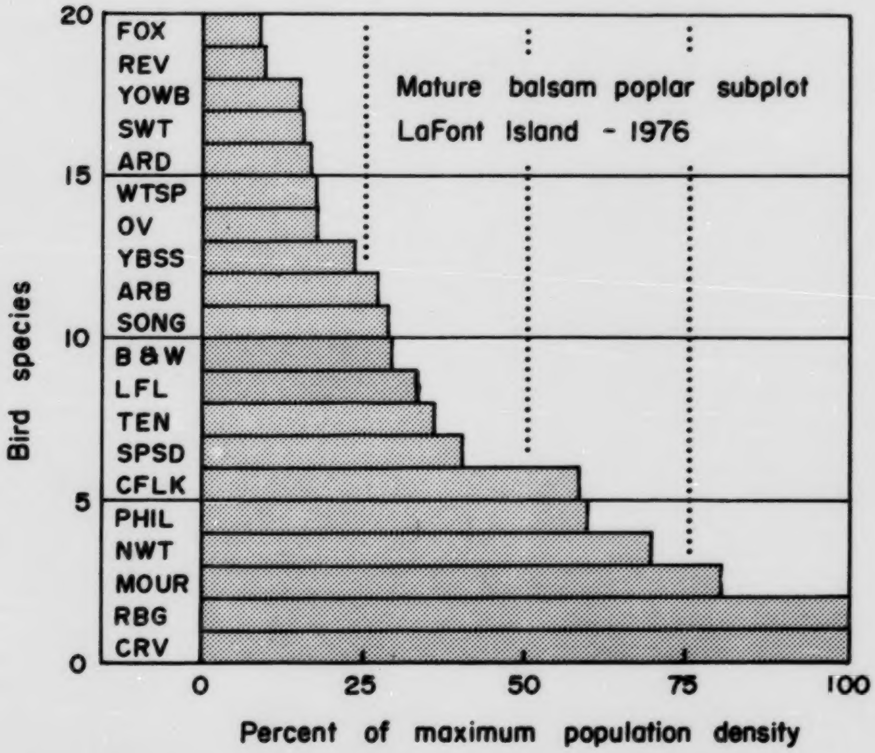


Figure 20. Species/habitat saturation histograms for the LaFont Island subplots.

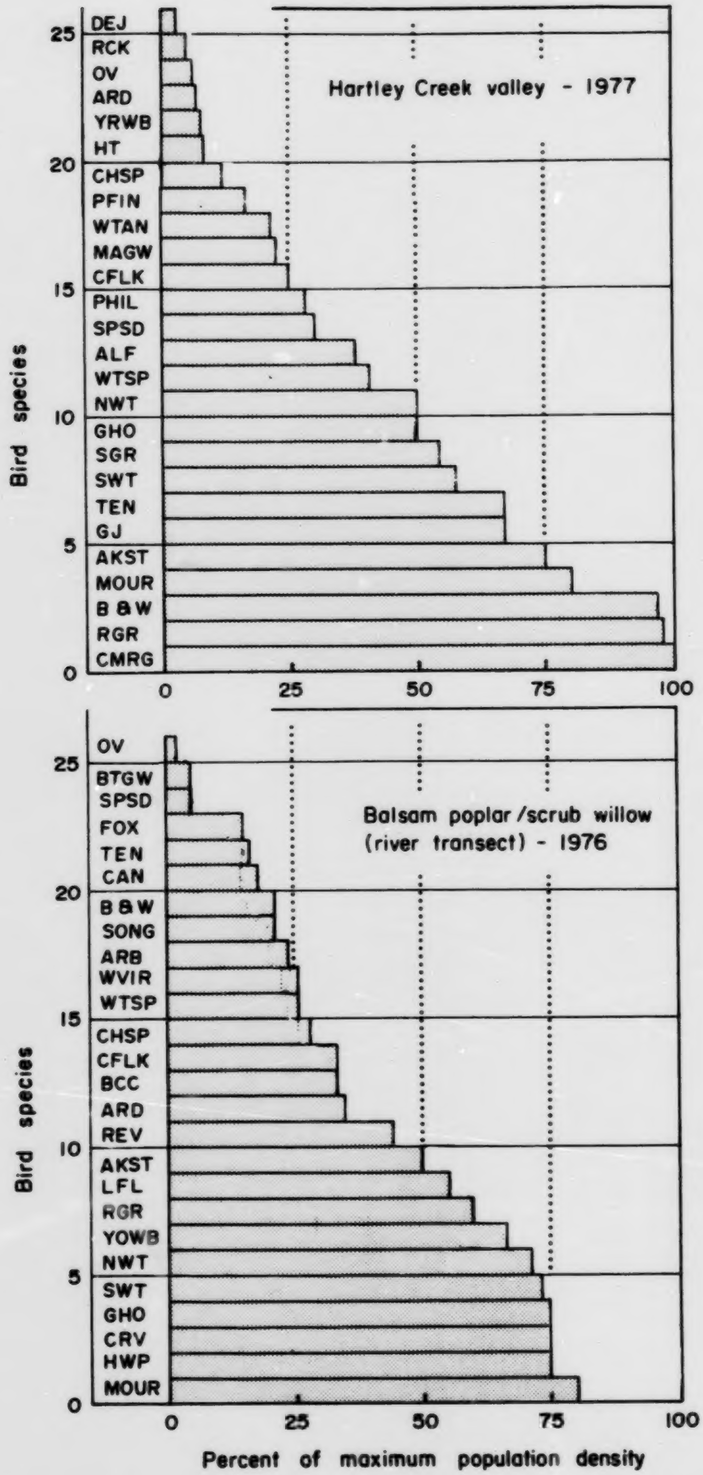


Figure 21. Species/habitat saturation histograms for Hartley Creek valley and the bottomland mature balsam poplar/scrub willow plots.

Seven bird species (Mallard, Blue-winged Teal, Wigeon, Yellow Warbler, Northern Waterthrush, Fox Sparrow, and Song Sparrow) were associated with water or willow/water interfaces. In total they accounted for 142 territories per 100 ha. The mature willow, then, could be expected to support approximately 356 territories per 100 ha of 24 species, with a C.I.N. of approximately 11. This bears a strong similarity, both in C.I.N. and in species composition, to other deciduous forests.

The shrubs in Stratum 2 on this plot were generally scattered to open, a condition which has thus far been associated with relatively low population levels. The mitigating factor in this instance was probably the fact that the foliage on the willow in Stratum 3 extended down to 2 or 3 m above the ground, creating an equivalent to dense, tall growth in Stratum 2.

Stratum 3 was generally dense or closed, however, several sedge clearings were present within the plot. These openings provided many incidental niches and probably accounted for the presence of several species (Black-billed Magpie, LeConte's Sparrow, Clay-Colored Sparrow and Swamp Sparrow).

In summary, bottomland mature willow can be expected to support an abundant and diverse breeding avifauna. Oxbows harbour breeding populations of several species of waterfowl (Mallard, Blue-winged Teal, Wigeon, and probably Green-winged Teal) in addition to a normal complement of water-edge associated species. Mature willow forest can be expected to support a population and species richness similar to other deciduous forests. Stratum 3 foliage extending down into the Stratum 2 layer appears to have a similar value to bird populations as shrub foliage at the same height and density. Sedge clearings add considerably to the species richness in a mature willow habitat by creating incidental niches.

The LaFont Island plot incorporated about 2 km each of three types of interface: tall forest/river, tall forest/willow scrub, and willow scrub/river. The abundance of edge-associated species found on the plot illustrated the value of these interfaces.

The island was split into two subplots in order to assess the value of the habitats themselves as opposed to the value of the interfaces.

The balsam poplar stand was tall (approximately 19 m), forming a closed canopy which exhibited little height diversity. Stratum 2 was generally open, except along the interfaces, where dense to closed foliage was present at all heights. In the stand interior, a gap of over 10 m was present between shrub and tree foliage. According to the habitat evaluation criteria thus far deduced, the breeding bird population of this forest should have been neither abundant nor diverse except along the interfaces. This proved to be the case (Table 14 and Figure 20).

The willow on the willow subplot formed a canopy which was uniformly closed and varied in height from 3 to 7 m. However, the height of the willow varied along the length of the island and, within any given 50 x 50 m block, willow was characterized by a lack of height diversity. This, coupled with the sparsity of cover on the ground, may explain the lack of an abundant or diverse breeding avifauna within the interior of the willow subplot (Figure 20). Of the avifauna on this subplot, 46% of the total population showed a definite edge association (Yellow Warbler, Northern Waterthrush, American Redstart, Fox Sparrow, and Song Sparrow).

The term "edge-associated" has been applied quite conservatively to the populations on both subplots. Several other species (Common Raven, American Robin, Black-and-white Warbler, and Tennessee Warbler) may also have been attracted by the edge situations. The "habitat minus edge-associated species" figures cannot be taken to represent the absolute value of the habitats, an interspecific competition may be a factor in the low population levels of some species.

The Bottomland Mature Balsam Poplar/Scrub Willow:

The willow scrub on this plot was somewhat shorter (2 to 4 m) than the willow on LaFont Island but was otherwise similar, as were the breeding bird populations of the two.

Table 14. Value of habitats and interfaces on LaFont Island plot.

Habitat	Terr/100 ha	Species Richness	C.I.N.
Mature balsam poplar-including interfaces	425	20	13
Interface-associated species	214	8	
Mature balsam poplar minus interface-associated species	211	12	8±
Scrub willow including interfaces	365	17	9
Interface-associated species	168	5	
Scrub willow minus interface-associated species	197	12	5±

The balsam poplar forest portions of the two plots differed considerably. The tree canopy on LaFont Island was closed and of uniform height. The tree canopy on the bottomland plot had many openings. A scattered to open subcanopy of 6 to 8 m tall river alder and 10 to 15 m tall aspen was present beneath the 18 to 23 m tall balsam poplar and provided considerable foliage height diversity and horizontal foliage/space diversity. Stratum 2 in this stand was dense, diverse in height, and comprised several species.

According to the habitat evaluation criteria induced thus far, this forest should have supported an abundant and diverse breeding bird population. It did: 25 species bred in this forest, at combined densities of at least 600 territories per 100 ha.

This plot incorporated 1.5 km of each of two interface types, balsam poplar forest/willow scrub and willow scrub/river. Seven species (American Kestrel, Spotted Sandpiper, Yellow Warbler, Northern Waterthrush, American Redstart, Fox Sparrow, and Song Sparrow) showed a definite edge association; their combined density was 191 territories per 100 ha.

In summary, this plot illustrates that abundance and diversity of breeding avifauna are high in the presence of the following conditions: forest/scrub and scrub/river interfaces; a deciduous canopy with openings; a deciduous canopy which, while predominantly tall, exhibits considerable height diversity; and a shrublayer stratum that is dense and diverse in height. It appears likely that each of these conditions contributes to increasing abundance and diversity of breeding avifauna.

The Hartley Creek valley plot was selected in order to assess the effects of a small creek on avifauna populations. This small creek, usually less than 3 m wide, was typically bounded on each side by 5 m tall willow and alder. The width of the valley floor was on occasion 150 m, however, it was typically less than 100 m.

The fact that the willow-alder stand was not extensive may have limited populations of some bird species typically associated with riparian willow habitats (i.e., Yellow Warbler, American Redstart, and Fox Sparrow). The narrowness of the creek often allowed the canopies of willow on either bank to overhang to such an extent that the horizontal foliage/space diversity was greatly reduced. This probably limited populations of Yellow Warblers and American Redstarts.

Of the 26 species breeding on this plot, only two (Common Merganser and Spotted Sandpiper) were associated with the creek itself. The Alder Flycatcher, Northern Waterthrush, and Mourning Warbler were associated with the willow habitats adjacent to Hartley Creek. For the Alder Flycatcher and Mourning Warbler this may have represented an association with the horizontal willow foliage/space diversity found along the creek. Black-and-white Warbler and American Redstart were associated with the entire successional gradient of habitats from the creek edge to the upland forest. Of the remaining 19 species, population densities in the mixed habitats of the valley slopes and adjacent uplands were typical of those habitat types and were not noticeably affected by the proximity of Hartley Creek.

The slopes of this valley were probably the most important factor contributing to the relatively high abundance and diversity of avifauna breeding on this study plot. Not only were a variety of habitats available on these slopes, but height diversity, foliage height diversity, and horizontal foliage/space diversity were quite high. Consequently, suitable habitat was present for many different species.

Summary:

While small creeks may not be as important to riparian-associated bird species as are rivers, the valley slopes often associated with these waterways are quite valuable to a wide variety of other bird species.

4.4.3.4.7 Habitat Mixtures

Text Reference

Plot	Plot density data	Subplot density data	Habitat Description
Bitumount muskeg (1976) (1977)	Table 39	Table 50	P. 314
Interface plot	Table 33	None	P. 304
Young mixed forest plot - Subplot 4	N/A	Table 45	P. 289

The 1976 data from the Bitumount Muskeg plot indicated that the plot represented excellent breeding bird habitat. The fact that the plot comprised a number of different habitat types posed a problem with respect to evaluation: were the diversity and abundance of breeding avifauna a function of the plot being a mixture of habitat types with an abundance of interfaces, or were the individual types all "good" habitat? In 1977, the interface plot was selected in order to resolve these questions.

Aspen and mixed forests were found on low ridges while the muskeg habitats were found in the shallow low-lying areas between the ridges. The bog areas were dominated by 1 m tall swamp birch in some areas and by dense young black spruce in others. Young aspen on the tops of the ridges, pine on the slopes and sparse shrublayer characterized the uplands. Thus the interface plot comprised several habitats, none of which, according to the criteria thus far induced, could be expected to support an abundant or diverse breeding avifauna (Figure 22).

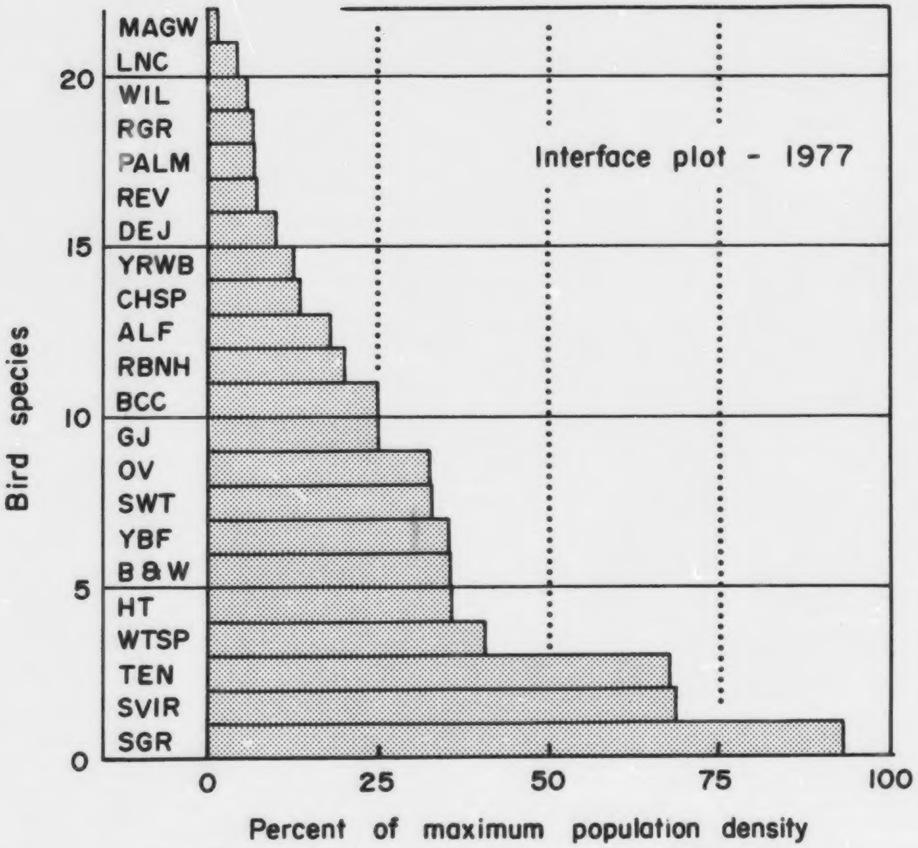


Figure 22. Species/habitat saturation histograms for the interface plot.

Three bird species, Solitary Vireo, Tennessee Warbler, and White-throated Sparrow, were present on the plot in much greater densities than would have been expected in any of the plot's component habitats (see Appendix 7.1 for habitat preferences of these species). These species were mainly associated with the interfaces between the bog and upland habitats. Two other species, Black-and-white Warbler and Swainson's Thrush, are normally associated with foliage height profiles which were, on this plot, most prevalent along these interfaces.

These five species constituted over half the total population on the plot, however not all of these territories can be ascribed to the interfaces. Most of these species would have been present (at lower densities) in at least one of the plot's component habitats. Somewhere between one half and two thirds of these territories (about 75 to 100 territories per 100 ha) would approximate the value of the interfaces.

The "willow bog and adjacent forest" subplot of the young mixed forest plot reveals a similar pattern, although the increase in abundance appears to be less dramatic.

While Swainson's Thrush, Black-and-white Warbler, and Tennessee Warbler are all present in fairly high numbers, only the Tennessee Warbler shows a clear preference for this subplot. (An explanation of the relative values of interface types is presented in Section 4.4.3.4.8).

The bird populations found on the interface plot and the "willow bog and adjacent forest" subplot are noteworthy in another respect. The shrub bog components of these plots seemed quite suitable for several bird species which were very sparse or absent. Clay-coloured Sparrow and Le Conte's Sparrow were entirely absent; Alder Flycatcher was entirely absent from the "willow bog and adjacent forest" subplot; and Lincoln's Sparrows were sparse on both plots. It seems likely that these shrub bog habitats were not extensive enough for these species, in spite of being much larger than the normal territory size.

Neither the interface plot nor the "willow bog and adjacent forest" subplot supports a great abundance of breeding avifauna, in spite of the presence of interface associated species. The implication seems to be that mixtures of "poor" habitats may support somewhat higher populations than would any of the component habitats, but the overall value of such mixtures remains relatively low.

A comparison of the species/habitat saturation histograms for the interface plot (Figure 22) and the Bitumount muskeg plot (Figures 16 and 17) reveals that the latter seems to be more suitable to more species. A perusal of the individual species maps for the Bitumount muskeg plot suggested that those species which are frequently edge-associated (Swainson's Thrush, Tennessee Warbler, Black-and-white Warbler, White-throated Sparrow) were relating no more to the interfaces than to the interiors of the component stands themselves.

Summary:

Mixtures of habitat types may support somewhat higher total populations than would any of the component "types", due to the presence or increased abundance of interface-associated bird species. Mixtures of "good" habitats will be more suitable to more bird species than will mixtures of "poor" habitats.

4.4.3.4.8 Interfaces. For the purposes of this report, the word interface has been used as a generic term for the zone of junction between two habitat types.

This section concerns itself only with interfaces between habitats of different heights. Interfaces between habitats of similar heights (e.g., between a 10 m tall aspen forest and a 10 m tall pine forest) were not observed to have any value to avifauna; i.e., no particular bird community was present along such edges.

Interfaces between habitats of different heights can be divided into three general types:

1. Simple interfaces: The two habitats are divided along a narrow line with no zone of intergrading (Figure 29). Simple interfaces are characterized by a wall of foliage at the edge of the taller habitat.
2. Ecotones: The habitat change occurs more gradually; forming a band which is a combination of the two habitats.
3. Successional Gradient: This term refers to the situation where three or more habitats, each forming a relatively narrow band, are present. This situation commonly occurs in areas where there is a rapid change in the water regime over a short distance. Figure 32 illustrates this phenomena: In a relatively short distance the water regime has changed from saturated to well drained and along this gradient different bands of vegetation are situated according to their moisture requirements.

An interface between habitats of different heights tends to present a wall of foliage along the edge of the taller habitat, even if the interior of this habitat is characterized by a huge unfoliated gap between tree and shrub foliage. An example of this phenomenon occurred on LaFont Island and is illustrated in Figure 29. This foliage "wall" provides a foliage height diversity profile not available in the interior of the habitat, thus bird species that require tall shrub or subcanopy foliage will be present along the interface, but absent from the forest interior. This wall of foliage also provides exposed song perches and hawking perches at all levels above the top of the shorter habitat (Figure 29). The height of the shorter habitat can be quite important. Many interface-associated species require horizontal foliage/space diversity (for exposed song or hawking perches or other reasons) between 2 and 7 m above ground (Table 15). Thus, if the shorter habitat is 7 m or taller with a closed canopy, the interface will be unattractive for these bird species.

Table 15. Interface and stand interior habitat preferences for selected species.

Species	Interface habitat	Stand interior habitat
Least Flycatcher	Interfaces in dry to mesic areas which provide both willow foliage and horizontal foliage/space diversity between 3 and 8m above ground.	Dry to mesic forests which provided both willow foliage and horizontal foliage/space diversity between 3 and 8 m above ground
Swainson's Thrush	Interfaces which provide deciduous or mixed (willow or willow/spruce preferred) foliage at all levels between 2 and 6 m above ground.	Stands which provide deciduous or mixed (willow or willow/spruce preferred) foliage at all levels between 2 and 6 m above ground
Red-eyed Vireo	Edge of dry to mesic deciduous forest. Abundant in forest/shrub ecotones which provide considerable horizontal foliage/space diversity.	Dry to mesic deciduous forests. Prefers stands which provide considerable horizontal foliage/space diversity in or immediately below tallest layer of tree canopy.
Solitary Vireo	Edges of tall coniferous stands; bands of scattered spruce or pine in successional gradients. (i.e., prefers horizontal foliage/space diversity at treetop level).	Coniferous or mixed stands in which openness or height diversity provides considerably horizontal foliage/space diversity at treetop level.

continued ...

Table 15. Continued.

Species	Interface Habitat	Stand interior habitat
Black-and-white Warbler	Forest/shrub ecotone or interface in mesic to wet area which provides dense to closed foliage between 4 to 10 m above ground.	Any mesic to wet habitat which provides open to closed foliage between 4 to 10 m. Scattered clumps of foliage below a closed canopy also acceptable.
Tennessee Warbler	Any interface between deciduous or mixed habitats which provide considerable horizontal foliage/space diversity somewhere between 3 m above ground and treetop level.	Any deciduous or mixed habitat which provides considerable horizontal foliage/space diversity somewhere between 3 m above ground and treetop level.
Mourning Warbler	Interfaces which provide a wall of deciduous or mixed foliage between 2 and 10 m above ground. Horizontal foliage/space diversity very important.	Uncommon in forest interior. Found around dense clumps of deciduous or mixed shrubs and trees 2 to 10 m tall, in open habitats.
Common Yellowthroat	Bands of willow in successional gradient between uplands and fen or marsh.	Willow fen.
American Redstart	Interfaces in dry to mesic habitats which provide deciduous foliage between 2 8 m above ground beside open space.	Dry to mesic habitats which provide deciduous foliage and considerable horizontal foliage/space diversity between 2 and 8 m above ground with taller tree canopy absent or open.

continued ...

Table 15. Concluded.

Species	Interface Habitat	Stand interior habitat
Red-winged Blackbird	Bands of willow or cattail in successional gradient between uplands and marsh or sedge fen.	Cattail marshes.
Common Grackle	Bands of live or dead willow in successional gradient between uplands and lake or herbaceous fen or marsh.	No other natural habitats. Abounds in disturbed areas.
Chipping Sparrow	Interfaces which provide foliage height diversity between 3 and 8 m above ground plus horizontal foliage/space diversity at treetop level (conifers preferred).	Any habitat which provides foliage height diversity between 3 and 8 m above ground plus horizontal foliage/space diversity at treetop level (conifers preferred).
White-throated Sparrow	Any ecotone or successional gradient which provides short trees or tall shrubs and some horizontal foliage/space diversity. Some deciduous foliage necessary.	Any habitat which provides short trees or tall shrubs, with taller tree canopy absent or open. Some deciduous foliage necessary.

Interfaces vary tremendously in value; some support an abundance of avifauna, while others are almost unoccupied. The difference appears to be a function of height diversity, foliage height diversity, and horizontal foliage/space diversity. The successional gradient in the "willow bog and adjacent forest" subplot of the young mixed forest plot supported only a minimal edge-associated avifauna. The pine and aspen canopy gave way to closed black spruce which diminished in height towards the willow bog. This provided comparatively little foliage height diversity and height diversity, and no horizontal foliage/space diversity; as a result it provided no exposed song and hawking perches. The successional gradient on the interface plot (Figure 32) provided considerably more height diversity and foliage height diversity, and some horizontal foliage/space diversity and appears to have been much more suitable to several edge-associated species. (These two plots are discussed in Section 4.4.3.4.7.)

The successional gradient between mixed forest and sedge fen provided a good foliage height profile and clumped shrubs. This edge supported fair numbers of several species (Table 16). (The absence of aerial feeding species, e.g., Eastern Kingbird, from this edge is inexplicable to the authors.)

Eight bird species bred along the deciduous forest/scrubs willow interface on the LaFont Island plot (Table 16), but none was abundant. The probable explanation is that the shorter habitat, the willow scrub, was frequently 5 to 7 m tall and was invariably closed. Thus, there was a minimum of horizontal foliage/space diversity below 5 to 7 m; this probably accounted for the very low numbers of Least Flycatchers and American Redstarts. Three other species, Swainson's Thrush, Black-and-white, and Tennessee Warbler, which are often edge associated, were present in both habitats, but showed no apparent affinity for the interface.

The majority of species found along this interface (i.e., Yellow Warbler, Northern Waterthrush, Fox and Song Sparrows) were

Table 16. Linear densities (territories/km) of bird species associated with interfaces.

SPP	Forest/Sedge Fen Ecotone	Deciduous Forest/ Scrub Willow-LaFont Is.	Deciduous Forest/ Scrub Willow. Mature Balsam Poplar Scrub Willow Plot	Willow/River LaFont Is.	Willow/River-Mature Balsam Poplar/Scrub Willow Plot	Tall Deciduous Forest/River-LaFont Is.	Tall Mixed Forest/River-River Valley Mixed Forest Plot.
Spotted Sandpiper				0.1	0.2	0.7	0.7
Least Flycatcher		1.8	10.7	0.4		4.3	
American Robin			0.7				
Swainson's Thrush			4.7				
Red-eyed Vireo			5.7				
Black-and-White Warbler			1.3				
Tennessee Warbler			2.7				
Yellow warbler	1.5	1.8	3.7	1.5	5.2	1.2	0.7
Northern Waterthrush		2.1	6.7	3.1	0.3	2.5	1.0
Mourning Warbler		0.7	0.7			1.4	0.2
Common Yellowthroat	0.3						
American Redstart		0.8	7.3	5.4		2.8	2.0
Red-winged Blackbird	9.5						
Common Grackle	2.0						
Chipping Sparrow			2.0				
White-throated Sparrow			1.3				
Fox Sparrow		0.5			1.3		
Lincoln's Sparrow	1.0						
Song Sparrow		1.2	0.3	3.4	3.1	2.1	2.1
Total Density	14.3	8.9	47.7	13.9	10.0	15.0	6.7
# of species	5	8	13	6	5	7	6

probably associated with the high water channel (and the 1 to 4 m wide horizontal foliage gap) which ran along this interface rather than the "wall" of foliage.

The deciduous forest/scrub willow interface from the mature balsam poplar/scrub willow plot was actually part simple interface and part ecotone. The interface portion differed from its counterpart on LaFont Island in that the willow was shorter, rarely exceeding 2.5 m. (Thus the foliage "wall" extended from about 2 m to over 20 m) In the ecotone portion, there was, in addition to the foliage "wall", an area 10 to 50 m wide in which the willow was 2 to 5 m tall (scattered clumped to open) and the balsam poplar was 5 to 10 m tall (scattered to scattered clumped). This provided foliage height diversity, height diversity and horizontal foliage/space diversity. The interface and ecotone types were not separated for the linear density calculations; the segments would have been so small as to preclude any confidence in the data. Data from the "forest, ecotone and willow scrub" subplot (Table 16) suggest that several species (Least Flycatcher, Warbling Vireo, Black-and-white, Tennessee and Yellow Warblers, Northern Waterthrush, and Chipping Sparrow) preferred the ecotone section, and that one species (American Redstart) preferred the interface section. These were certainly the most abundantly and diversely populated edge habitats encountered in this study, and the ecotone was distinctly preferable to the interface for a majority of bird species.

The two willow/river interfaces differed primarily in one respect: willow on LaFont Island was generally 4 m or taller whereas on the mature balsam poplar/scrub willow plot it was 2 to 2.5 m tall. The data (Table 16) suggest that certain species (Northern Waterthrush and American Redstart) prefer the taller willow, while others (Yellow Warbler and Fox Sparrow) prefer the shorter willow.

The tall deciduous forest/river interface on LaFont Island presented a vertical wall of foliage from the ground to the tops of the trees (about 19 m). This "wall" was fairly narrow, extending only a few metres back into the forest. This edge was inhabited by fair numbers of seven species, and may in fact have supported a larger population than Table 16 suggests. Territories of several Tennessee Warblers and several Mourning Warblers, which were not included in the calculations, may in fact have been associated with this edge. (Their territories did not seem to be aligned along the edge, yet the forest interior was not particularly suitable for either species.)

The tall mixed forest/river interface from the river valley mixed forest plot was probably the least populated of the edge types studied. It was characterized by a 3 to 10 m tall bank nearly vertical and frequently unvegetated. Much of the foliage "wall" consisted of spruce, speckled alder, and rose. In two areas, a band of scrub willow was present at the bottom of the bank. Three of the bird species present along the tall mixed forest/river interface (Yellow Warbler, Northern Waterthrush, and Song Sparrow) were present solely in the bands of willow. Thus, only three species (American Redstart, Mourning Warbler, and Spotted Sandpiper) were associated with the mixed forest/river interface. (Mourning Warbler densities along this interface may have been underestimated for reasons mentioned above.) The paucity of avifauna along this interface likely is due to a combination of factors: alder and rose do not seem to be heavily utilized by avifauna; there seem to be fewer species utilizing coniferous edges than deciduous edges; and the height of the bank probably reduced the attractiveness of this edge for some species.

Summary:

No apparent edge-associated bird community was found along interfaces between stands of similar height. Interfaces between stands of different heights do support edge-associated bird communities, frequently involving bird species which are not present in the interior of either stand. The value of interfaces seems to be a function of three variables: foliage height diversity, plant height diversity, and horizontal foliage/space diversity. Those species not specific to water/land interfaces are generally associated with the same combinations of these variables along interfaces and ecotones as they are in stand interiors. A number of bird species are associated with horizontal foliage/space diversity between 2 and 7 m above ground. These bird species will not utilize interfaces in which the shorter habitat is more than 7 m tall. The avifaunal community associated with coniferous-dominated interfaces seems to be less diverse and abundant than that associated with deciduous-dominated interfaces. The population data suggest that the avifaunal community along an interface is present in addition to, rather than at the expense of, the stand interior bird communities.

4.4.3.5 Significance of Habitat Variables

4.4.3.5.1 Introduction: The habitat relationships of avifauna. The distribution of foliage, vertically and horizontally, appears to be the major key to habitat value. Three quantitative categories are necessary to an understanding of the relationships of avifauna to foliage distribution:

1. Foliage height diversity: Number of height levels in a habitat at which foliage is present. (Deciduous and coniferous foliage should be considered separately.)
2. Height diversity: Diversity of height of trees and shrubs.
3. Horizontal foliage/space diversity: Presence of dense clumps of foliage and open space at any given height level.

Other considerations - plant species composition, presence of overmature trees or standing dead spars, adequacy of cover at any given height for nesting and feeding - are also important.

A summary of the overall relationships of bird species to habitat is complicated by two factors:

1. It appears that birds respond to four general foliage height classes rather than the three plant height classes utilized for habitat quantification in this study.

2. The significance of foliage at a given height level is dependant on the presence or absence of foliage above that level.

Accordingly, this summary will discuss habitat in terms of four foliage height classes and four habitat height classes (Table 17).

4.4.3.5.2 Topography. For almost all breeding avifauna in the study area, with the exception of the Canada Warbler, topography is not directly significant. For these species, variability of water regime, plant species composition, density or height created by a varied topography is of more importance. However, it appears that the Canada Warbler may be directly associated with slopes.

4.4.3.5.3 Water Regime. Water regime is only directly important to a few species (e.g., Swamp Sparrow, Rallids, Sandpipers). Most other species seem to be associated with the plant communities typical of certain water regimes.

The typical forest in very dry areas is pine, generally with a lichen/scattered heath ground cover community and little or no shrublayer. This habitat supports a very limited breeding avifauna, which is probably attributable more to the sparsity of foliage near the ground than to the tree cover.

Very wet sites, where the standing water is deep enough to preclude woody-stemmed plants, are characterized by lush growth of grasses, sedges, rushes, or cattails. These habitats (marshes or fens) support a low diversity of breeding avifauna, but may support a tremendous abundance of a few species.

Habitats in which the water regime is between these two extremes tend to support a somewhat higher diversity of breeding avifauna.

4.4.3.5.4 Ground Cover Stratum. Some Stratum 1 only habitats, such as lush growths of sedges of rushes, can support six or more species, some of them in great abundance. Presence of a layer of low shrubs

Table 17. Foliage height and habitat height classes used in the discussion.

Class	Foliage Height Class	Habitat Height Class
Stratum I (Ground Cover)	Woody stemmed plants less than 0.5 m tall plus all herbaceous plants.	Stratum 1 only habitats.
Low Shrub Layer (includes short trees)	All shrub and tree foliage between 0.5 and 3 m above ground.	Low shrub habitats. Woody stemmed plants taller than 0.5 m are present, but little or no foliage above 3 m.
Tall shrub layer (includes young trees)	All shrub and tree foliage between 3 and 7 m above ground.	Tall shrub habitats. Habitat taller than 3 m but little or no foliage extends above 7 m.
Trees/Forest	Foliage above 7 m.	Forest; trees mostly taller than 7 m.

(i.e., less than 3 m tall) does not preclude an abundant and diverse Stratum 1 oriented bird population. Forests and tall shrub habitats, however, seem rarely to support more than two to four species of Stratum 1 oriented birds.

The low bird population density and diversity found on the mature jack pine plot (Table 25), and in particular the complete absence from that plot of ground-oriented birds such as grouse and thrushes, suggest that the lichen/scattered heath ground stratum was unsuitable for most bird species. The low density and diversity of birds on the young jack pine plot and the relatively low density and diversity of birds not associated with interfaces on the willow subplot of LaFont Island may have been a function of the scattered to open ground stratum which characterized both habitats. The ground strata in all the other dry to moist habitats were mixtures of forbs, low shrubs and grasses, and were mostly dense or closed. This uniformity prevents a further breakdown.

4.4.3.5.5 Low Shrub Habitats. Low shrub habitats, consisting primarily of shrubs and/or trees between 0.5 and 3 m tall, generally support four to 10 integral species. Abundance of breeding avifauna can be quite variable and can vary from 100 to over 600 territories per 100 ha. In this height class, diversity of breeding avifauna tends to be higher in pure deciduous habitats than in pure coniferous habitats.

The capacity of low shrub habitats to support abundance and diversity of breeding avifauna seems to be influenced by several variables. Higher avifaunal abundance and diversity are associated with the following:

1. Increasing height;
2. Foliage dense enough to provide good cover;
3. Plant (i.e., low shrub) height diversity;
4. Horizontal foliage/space diversity;
5. Deciduous-coniferous mixtures;
6. Presence of scattered taller shrubs or trees;

7. Presence of dead spars; and
8. Lush ground cover stratum foliage.

Plant species considerations are summarized in Section 4.4.3.5.9.

4.4.3.5.6 Tall shrub habitats. Tall shrub habitats are those in which a layer of shrub and/or tree foliage extends above 3 m but in which little foliage extends above 7 m. Coniferous habitats in this height class tend to support low to moderate diversity and abundance of breeding avifauna. Deciduous and mixed habitats in this height class tend to support nine to 16 integral species and densities can vary from 200 to at least 500 territories per 100 ha.

Higher abundance and diversity of breeding avifauna are associated with the following variations:

1. Increasing height (value of increasing height may be offset if a foliage gap is present below tall shrub foliage layer);
2. Height diversity in plants more than 1 m tall;
3. Horizontal foliage/space diversity at all height levels above 1 m;
4. Deciduous-coniferous mixtures;
5. Foliage height diversity. In mixed habitats, presence of both deciduous and coniferous foliage at all levels;
6. Presence of dead spars or scattered tall trees;
7. Lush ground cover stratum foliage; and
8. Presence of a low shrub layer. Low (i.e., below 3 m) foliage on taller shrubs and trees can partially mitigate absence of a low shrub layer.

Plant species considerations are summarized in Section 4.4.3.5.9.

4.4.3.5.7 Forests. Forests are those habitats in which the trees are generally taller than 7 m. Coniferous forests generally support less than 300 territories per 100 ha; diversity has been observed to vary from four to 11 integral species. Deciduous forests vary considerably; abundance of breeding avifauna can vary from as low as 100 to at least 600 territories per 100 ha and diversity can vary from four to 11 integral species. Abundance and diversity of breeding avifauna in mixed forests varies considerably; abundance of breeding avifauna can vary from as low as 200 to at least 600 territories per 100 ha and diversity may exceed 23 integral species.

In coniferous forests, higher abundance and diversity of breeding avifauna are associated with the following variations:

1. Increasing age and height;
2. Increasing foliage height diversity;
3. Tree height diversity;
4. Horizontal foliage/space diversity, particularly at tree top level;
5. Presence of low or tall deciduous shrubs;
6. Amount of cover provided by ground cover stratum;
7. Openings in tree canopy or an open tree canopy; and
8. Presence of overmature or standing dead trees.

In deciduous forests, foliage 2 to 7 m above ground appears to be much more important to breeding avifauna than foliage above or below this level. The following habitat characteristics are associated with higher abundance and diversity of breeding avifauna in deciduous forests:

1. Foliage height diversity between 2 m above ground and the bottom of the tree canopy (i.e., presence of shorter trees or tall shrubs or both);
2. Increasing stand height if no foliage gaps are present;
3. Shorter trees and tall shrubs open as opposed to scattered;
4. Horizontal foliage/space diversity, particularly between 3 m above ground and the bottom of the densest layer of tree canopy foliage;
5. Horizontal foliage/space diversity in treetops;
6. Lush ground stratum foliage; and
7. Presence of overmature or standing dead trees.

In pure deciduous and pure coniferous forests, foliage height diversity is probably the most important single factor. In mixed forests, this becomes somewhat more complex. If coniferous foliage only is present in certain height levels, suitability of a stand for deciduous-oriented species is limited. Thus, for mixed forests, foliage height diversity must be considered separately for deciduous and coniferous components. In mixed forests, as in deciduous forests, the 2 to 7 m stratum appears to be much more important than the 0.5 to 2 m stratum; however, the tree stratum is more important than either.

In mixed forests, higher abundance and diversity of breeding avifauna are associated with the following variations:

1. Deciduous foliage height diversity (i.e., presence of deciduous foliage at all height levels);
2. Coniferous foliage height diversity;
3. Horizontal foliage/space diversity, at all levels more than 2 m above ground;
4. Height diversity, at all levels more than 2 m above ground;
5. Increasing tree height;
6. Lush ground stratum foliage; and
7. Presence of overmature or standing dead trees.

Plant species considerations for all forest types are summarized in Section 4.4.3.5.9.

4.4.3.5.8 Interfaces. Interfaces between habitats of similar height were not observed to support an edge-associated breeding bird community.

Interfaces (including ecotones and successional gradients) involving habitats of different heights generally did support edge-associated breeding bird communities. The bird community found along an interface generally can be explained by four factors: foliage height diversity, height diversity, horizontal foliage/space diversity, and the presence of water. Deciduous edges are more diversely populated than coniferous edges.

Higher abundance and diversity of edge-associated breeding avifauna are associated with the following characteristics:

1. Deciduous foliage height diversity, particularly between 2 and 10 m above the ground;
2. Horizontal foliage/space diversity, particularly between 2 and 7 m above the ground;
3. Height diversity; and
4. Presence of water; even a narrow muddy high-water channel has several species associated with it.

4.4.3.5.9 Plant Species.

Ground Cover Stratum:

Hand analysis of the data revealed only one definite pattern: that when ground cover is scarce, ground-oriented birds are scarce. Berry-producing heaths are heavily utilized by grouse in late summer and fall, but heaths do not provide much cover. Mixtures of heaths and herbaceous plants are probably the most suitable upland ground cover. No majority preferences were apparent in water saturated habitats.

Shrubs:

Rose is probably less suitable for most bird species than any other low shrub. Most bird species appear to prefer willow to alder or swamp birch.

Trees:

Pine forest seems to be preferred habitat for only two species, the Common Nighthawk and, during the winter, the Spruce Grouse. For the other conifer-associated species, spruce is either as suitable as, or preferable to, pine. Many deciduous associated birds also use spruce; few use pine. Dominance of pine beyond about 25% of the tree canopy seems to reduce avifaunal abundance.

4.4.3.5.10 The Athabasca River Valley. More than any other portion of the study area, the Athabasca River valley contains a preponderance of "good" habitats. Three plot studies were conducted in the Athabasca

River valley, and each supported an abundant and diverse breeding avifauna (Tables 28, 29, 30). Casual observations of habitat and bird populations have led the authors to believe that these plots typify Athabasca River valley habitats.

The capacity of the river valley to support an abundant and diverse avifauna is informed by several general characteristics:

1. Abundance of forest/scrub, forest/river, and scrub/river interfaces;
2. Predominance of mature forests;
3. Predominance of mixed forest;
4. Relative prevalence of overmature stands; and
5. Presence of numerous oxbows and sloughs.

The authors have observed breeding populations of 97 species in the river valley, and are certain that at least 25 other species also breed there.

Because of the abundance and diversity of avifauna it supports, the Athabasca River valley represents an excellent base whence reclaimed areas may be colonized.

River valley habitats are among the most valuable in the study area. As such, they should be preserved as much as possible.

Particular attention should be given to the preservation of overmature forests in the Athabasca River valley because of both their considerable value to avifauna and their anticipated increasing scarcity elsewhere in the study area.

4.4.4 Impact of Development.

4.4.4.1 Introduction. The environmental impact of oil sands development will take four basic forms:

1. Habitat destruction;
2. Habitat alteration;
3. Disturbance; and
4. Chemical contamination.

This report deals with the impact on terrestrial avifauna of habitat destruction, habitat alteration, and disturbance. Chemical contamination is not addressed in this report, but we recommend that it be the subject of an intensive study in the near future.

The prediction of the impact of oil sands development is complicated by uncertainties as to exactly what form this development will take. It is assumed that, eventually, all surface-mineable deposits will be exploited, however the rate at which this occurs will be governed by economic and political factors which are beyond the scope of this study. The extent of, and techniques to be used by, in situ recovery operations are currently unknown. The current uncertainty about projected reclamation strategies renders long-term impact assessment difficult. Without precise knowledge of the projected water regime and plant species composition on reclaimed sites, it is impossible to predict the value of reclaimed habitats to avifauna.

Despite these limitations, some predictions can be made as to the prospective impact of oil sands development on avifauna.

4.4.4.2 Habitat Destruction. Oil sands development can be broken down into three phases: draining/clearing, mining/backfilling, and reclamation. Each of these phases will have a characteristic habitat type.

If more than a year elapses between the clearing and mining of an area, a low scrub growth condition will result. This scrub will have a characteristic breeding avifauna. The diversity of that avifauna would depend on a variety of factors: water regime, efficiency of clearing, and so on. The bird species involved would probably include: Common Nighthawk, Short-eared Owl, American Kestrel, Marsh Hawk, and several species each of shorebirds and sparrows. This would provide excellent habitat for migrating buteos and shorebirds.

During the mining/backfilling phase, breeding avifauna are likely to consist of those aerial feeding and scavenging species typical of developed areas; Common Nighthawk, Eastern Phoebe, Common Raven, Barn Swallow, Starling, and House Sparrow would probably be present.

The reclamation phase will be characterized by a gradually increasing diversity of breeding avifauna. During the first few decades, this will likely include several species (e.g., Sprague's Pipit, Western Meadowlark, American Goldfinch, and Vesper Sparrow) that are presently quite rare in the oil sands area.

Superficially, habitat destruction would appear to have the same effects on all bird species--it would force them to move elsewhere in search of suitable habitat. However, this is true only in the short term. The long-term effects on any given bird species will depend on the suitability of reclaimed habitats for that species. The duration of impact will depend on the degree of habitat maturity a bird species requires.

Those species presently inhabiting scrublands in the area will be the first to colonize reclaimed sites. As the scrubland gives way to forest, it will be colonized by forest-dwelling bird species. The last group of species to return will be the group that inhabits only overmature forest.

One group of species, those associated with water-saturated habitats, may not return. Water-saturated habitats cover much of the oil sands at this time, but are difficult to reclaim; natural processes may never recreate them on reclaimed areas.

Table 18 presents the prospective impact, and the anticipated duration of that impact, on various habitat types and their indigenous avifaunal groups.

A consideration of the long-term impact of oil sands development on individual bird species must take two factors into consideration:

1. Will suitable habitat be reclaimed; and
2. Will suitable habitat be present in the area in the interim to support populations of year-round resident species from which reclaimed habitat may be colonized?

Staggering of development (i.e., GCOS in 1966, Syncrude in 1978, and the next plant unlikely to be operational before 1985, etc.) will ensure that certain habitats will abound throughout the development

Table 18. Assessment of Potential Impact of Surface Mining (Habitat Destruction) on Avifauna.

Habitat	Value to avifauna generally	Importance to indigenous avifauna	Reclamation time	Present status in surface mineable area	Early reclamation period	Middle term 25-100 yr	Long term	Comments and impact on indigenous avifauna
Young forests	Moderate	Moderate	25	Very common	Absent	Very common	Common	Impact short term and minimal; staggering of development will ensure continuous availability of this habitat in the surface mineable area.
Mature deciduous forests	Low to Moderate	Low	60	Very Common	Absent	Becoming common	Common	Impact short term and minimal. Most indigenous species prefer younger stands
Overmature forests	High	High	150 or more	Uncommon	Absent	Absent	Becoming common	Impact long term and potentially serious due to increasing rarity of habitat as development proceeds.
Mature spruce	Moderate	Moderate	100	Uncommon	Absent	Absent	Common	Impact medium term and potentially serious in surface mineable area, although habitat will remain abundant in Birch Mtns. throughout development period.
Coniferous muskeg	Moderate	High	--	Very common	Absent	Nearly absent	Nearly absent	Impact serious and permanent; habitat unlikely to be completely eliminated, but will undergo substantial permanent reduction in surface mineable area. Habitat will remain abundant in Birch Mtns.
Fen	Moderate	High	--	Very common	Absent	Nearly absent	Nearly absent	Impact serious and permanent; habitat unlikely to be completely eliminated, but will undergo substantial permanent reduction in surface mineable area. Habitat will remain abundant to east and southwest of surface mineable area.
Pine	Low	Low	Young 20 Mature 60	Uncommon	See Reclamation Recommendations			Impact minimal. Habitat will remain abundant in area to northeast of surface mineable area.
Riparian Lakeshore	High	High	25	Uncommon	Becoming common	Common	Common	Impact not serious in short term, probably positive in long term.
Riparian river valley	High	High	--	Common	Less common	Less common	Less common	Impact will depend on degree and type of development but potentially significant and permanent.

period. Scrublands and young forests, for example, will have been reclaimed on some leases before clearing even begins on others. The impact of development on species for which these habitats are suitable, therefore, will be minimal.

Pine forests are fairly common in the area to be developed, but are abundant in the area to the northeast of the oil sands deposits. The loss of pine forests is not considered to be of great significance; the abundance and diversity of avifauna associated with pine forests are minimal, consisting almost entirely of species which prefer other habitats.

Young and mature deciduous forests abound in the area projected for future development. Species composition of breeding birds in young and mature deciduous forests is similar, although most bird species seem to prefer younger stands (it appears that nearly all bird species found in deciduous forests are also found, albeit frequently at lower population densities, in mixed forests). The staggering of development should ensure continuous availability of young deciduous forests, thus the impact on bird species associated with deciduous forest should be minimal.

Young spruce forests are fairly common in the area that will be developed; mature spruce forests are less common. Nearly all species associated with spruce also inhabit mixed forests, generally at similar population densities. The staggering of development should ensure continuous availability of young spruce, thus the impact of development on species associated with young spruce should not be severe. Several bird species are specific to mature spruce; several more are specific to mature conifers. Mature conifers will become less and less common in the short term as development proceeds, and many decades will elapse before they are present on reclaimed sites. Extensive stands of mature conifers will be present indefinitely in the Birch Mountains and the area between McClelland Lake and Lake Athabasca, but enclaves of them in the development area may be largely confined to the Athabasca River valley. This would result in a serious reduction, in the development area, of populations of those bird species specific to mature conifers. For several of these species which are not migratory, this might result in delayed colonization of mature stands when they become available on reclaimed sites. This problem would be obviated if development were staggered over a period of many decades, allowing presently young stands to mature, and thereby insuring continuous availability of mature conifers in the development area.

Overmature stands are those in which trees have commenced to die of old age, fall over, or otherwise absent themselves from the canopy. Young trees progressively fill the canopy openings thus created. Thus an overmature forest is actually a mixed-age stand. As such, overmature forests support all the species associated with young and mature stands plus a few others (Table 44), and are probably the most valuable habitats present in the oil sands area. Unfortunately they are also the least abundant.

Overmature deciduous forests are largely confined to bottomland situations, and are generally dominated by balsam poplar. Upland overmature forests are generally mixed, with white spruce growing up underneath aspen or pine, or else aspen or birch growing up in the openings in a spruce forest.

Well over 100 years elapse before a deciduous forest reaches this stage, somewhat longer for pine, and longer again for spruce. Thus overmature forests will not be present on reclaimed sites until the late 22nd century at the earliest.

As previously mentioned, overmature forests are scarce at this time, and will become more so as they are lumbered and/or cleared for mining. In order to maintain populations of those bird species specific to overmature forests whence reclaimed sites can be colonized, a few stands of overmature forest should be protected.

Water-saturated habitats abound in the oil sands area, and support an abundant and diverse breeding avifauna. Failure to reclaim water-saturated habitats will result in their eradication from mined sites and, in the long term, their near eradication from the surface mineable area. Water-saturated habitats will continue to abound in areas surrounding the surface mineable deposits.

Summary:

The main effect of habitat destruction will be the local reduction of the amount of habitat available for breeding birds. No unique habitats will be destroyed. Most habitats will continue to abound in the surface mineable area throughout the development period. Development will probably result in a significant decrease in the availability of overmature forest in the surface mineable area. This condition could continue for over 200 years. A temporary decrease in the availability of mature conifers might also occur if development proceeds rapidly. Development will likely result in the permanent near eradication of water-saturated habitats from the surface mineable area. Water-saturated habitats will continue to abound in the areas surrounding the surface mineable deposits.

4.4.4.3 Ancillary Alteration and Destruction of Habitat. Alteration or destruction of habitat will not be confined to drainage, clearing and mining operations; townsites, roads, and cutlines will also have some effects.

The impact of townsite development on avifauna can vary from "habitat alteration" to "habitat destruction". If trees are left standing whenever possible, and woodlots (preferably with the shrublayer left intact) are incorporated into the zoning scheme, a developed area can support an impressive breeding avifauna. [Studies conducted in some towns and suburbs in southern Ontario have found population levels much higher than would have been present in undisturbed forest (Erskine 1971, 1972, 1976)]. If development commences with the razing of the forest, a townsite would support only those aerial feeding and scavenging species associated with developed areas. This effect might be mitigated somewhat in the long run, as trees and ornamental shrubs are planted by residents.

The habitat alteration effected in the construction of roads and cutlines need not be detrimental. Cutlines create edge situations and provide niches for several species, while the suitability of the habitat for its previous residents is not appreciably altered. In the case of roads, however, factors other than habitat alteration come into play. Vehicular traffic could constitute a disturbance, as could the clouds of dust typical of unpaved roads. The effects of these disturbances are not known, but could be considerable.

The potential impact of ancillary development in the oil sands area can be minimized if roads and townsites are located so as to avoid, where possible, the most valuable bird habitats.

4.4.4.4 Disturbance and Bird Phenology. Habitat destruction and disturbance in the form of vehicular traffic and heavy equipment are unavoidable concomitants of oil sands development. It may be possible, however, to minimize their impact on avifauna.

If habitat is destroyed or subjected to an intolerable level of disturbance prior to the breeding season, bird populations will probably move elsewhere to breed. Habitat destruction or intolerable disturbance levels during the breeding season may well cause the abandonment of nests, and therefore prevent successful breeding. Thus, bird populations are at their most sensitive during the breeding season.

Breeding activity is largely limited to the period from 20 February to 20 August; a vast majority of species breed between 1 May and 30 July. The impact of clearing on avifauna would therefore be minimized if it were to take place between 20 August and 20 February. Similarly, localized and ongoing disturbances should commence prior to 20 February. This would probably prevent sensitive species from settling, rather than driving them away in the middle of the breeding season.

4.4.4.5 Sensitive Stenoecious Species. Sensitive stenoecious species, i.e., those species with relatively narrow niche tolerances, are potentially sensitive to development, since their choice of habitat is restricted. Most of these species will not be significantly affected by oil sands development because their habitats will remain abundant throughout the development phase (e.g., scrublands, young forests, deciduous forests, etc.). The sensitive species are those which are restricted to habitats which will undergo reduction or elimination due to oil sands development. The only habitats which will be thus affected are water-saturated habitats, overmature forests, and, to a lesser extent, mature conifers.

Although many species breed in water-saturated habitats, only a few of these species are restricted to them. Table 19 presents a list of the species associated with water-saturated habitats, and details the other habitats utilized by these species. Only eight species (Sandhill Crane, Common Snipe, Short-billed Dowitcher, Palm Warbler, Wilson's Warbler, Le Conte's, Sharp-tailed and Swamp Sparrows) are restricted to water-saturated habitats.

Thus, as development proceeds, these eight species are likely to undergo a substantial and permanent reduction in numbers in the surface mineable area. Suitable habitat will continue to be available outside the surface mineable area.

The species most affected by the absence of mature conifers and overmature forests would be the hole nesters. Six species of woodpeckers (Common Flicker, Yellow-bellied Sapsucker, Pileated, Hairy, Northern Three-toed and Black-backed Three-Toed Woodpeckers) require fairly substantial trees, preferably dead or dying, for nest hole excavation. Three other species (Black-capped and Boreal Chickadees, and Red-breasted Nuthatch) require rotting tree stubs or abandoned woodpecker holes for nest construction. Table 20 presents the habitat preferences of these nine species. Four of the nine are not restricted to mature forests; the presence of standing dead stubs or tiny refugia of mature trees would probably render young forests suitable for them. The other five species are generally restricted to mature, overmature or dying stands.

Of these nine species, six are non-migratory. If these species are extirpated from the lease areas, the recolonization of mature reclaimed habitats may be delayed by the distance between these habitats and populations elsewhere.

Table 19. Habitat preferences of bird species found in water-saturated habitats.

Species	Dec. Fen	Dec. Bog.	Yng.	Mtr.	Herbaceous Fens	Other Suitable Habitats
			Conifers			
Spruce Grouse			X	X		Coniferous & mixed forests
Sharp-tailed Grouse		X				Unknown
Sandhill Crane	X	X			Probably	None
Sora Rail					X	Lake edge emergents
Common Snipe	X	X				None
Greater Yellowlegs	X	X			X	Lake/river edge
Lesser Yellowlegs	X	X				Lake/river edge
Short-billed Dowitcher		X				None
Hawk Owl			X	X		Conifers
Common Flicker				X		Almost ubiquitous in mature stands
Hairy Woodpecker				X		Mature conifers and overmature decid
Northern Three-toed Woodpecker				X		Mature conifers
Eastern Kingbird		X				Lake edges
Yellow-bellied Flycatcher			X			Young mixed forests
Alder Flycatcher	X	X				Scrublands
Western Wood Pewee				X		Mature Conifers
Olive-sided Flycatcher				X		Mature Conifers
Gray Jay			X	X		Any coniferous or mixed habitat
Boreal Chickadee			X	X		" " "
Black-capped Chickadee		X				Any deciduous or mixed habitat
Swainson's Thrush	X	X	X	X		Almost ubiquitous
Ruby-crowned Kinglet			X	X		Spruce forests.
Black-and-white Warbler	X	X				Tall decid. scrub or forest with tall understory
Tennessee Warbler	X	X				Ubiquitous in decid. or mixed habitat
Orange-crowned Warbler		X				Forest with tall understory probably also in tall decid scrub.
Yellow-rumped Warbler			X	X		Any coniferous or mixed habitat
Palm Warbler			X			None
Common Yellowthroat	X					Lake & river edges in scrub
Wilson's Warbler	X	X				None
Red-winged Blackbird					X	Emergents at lake edge
Rusty Blackbird		X				Unknown
Savannah Sparrow		X				Probably in scrub growth
LeConte's Sparrow	X	X				None
Sharp-tailed Sparrow	X					None
Dark-eyed Junco			X	X		Any coniferous or mixed habitat
Chipping Sparrow			X	X		" "
Clay-colored Sparrow	X	X				Scrub growth
White-throated Sparrow		X				Most forests, forest edges, scrublands
Lincoln's Sparrow	X	X				Wet Riparian scrub
Swamp Sparrow	X					None

Table 20. Habitat preferences of hole nesting birds.

BIRD SPECIES	Limited by Nest Site only-young habitats suitable	Mature Coniferous or Mixed Forest	Overmature Forest or standing dead trees	Resident /Migrant
Common Flicker	S	S	S	Migrant
Yellow-bellied Sapsucker	S	S	P	Migrant
Pileated Woodpecker		S	P	Resident
Hairy Woodpecker		S	P	Resident
Northern Three-toed Woodpecker		S	S	Resident
Black-backed Three-toed Woodpecker			P	Resident
Black-capped Chickadee	S	S	S	Resident
Boreal Chickadee	S	S	S	Resident
Red-breasted Nuthatch		S	P	Migrant

S - suitable habitat

P - preferred habitat

Consequently, the duration of impact on these bird species associated with mature spruce and overmature forests may depend on the availability of undisturbed refugia within the development area. If the Athabasca River valley remains largely undeveloped, and if enclaves of pristine habitat (e.g., the MacKay River valley on Syncrude Lease #17) are maintained on the mining leases, then the impact on these species will be minimized.

4.5 CONCLUSIONS

The baseline states of avifauna in the oil sands area are typical of the boreal region in Canada. Population densities encountered in this study were roughly parallel to those found elsewhere in boreal Canada by Erskine and others (Erskine 1977). Many of the richer oil sands habitats supported population densities in the range of 500 to 800 pairs per 100 ha which are "comparable to all but the richest hardwood stands in the eastern deciduous forest ..." (Erskine 1977:23). The diversity of breeding avifauna in the oil sands area (169 species) is within 4% of the diversity present in an area of similar size in extreme southern Ontario. In summary, the oil sands area is not avifaunally impoverished; it supports an abundant and diverse breeding avifauna.

The habitat preferences and status of individual bird species are detailed in Appendix 7.1.

The development of a set of ecological maps at a scale of 1:50 000 for each avifaunal species or group of species was found to be impossible through the use of aerial photographs. One of the major habitat relationships determined during this study was the importance, to a significant number of bird species, of vegetation in the height range of 2 to 7 m. The habitat parameters necessary for avifaunal mapping were communicated to the personnel responsible for the photo interpretation. However, the maps subsequently provided for the AOSERP area were of limited or no use as they dealt strictly with forest cover type. As has been previously stated, bird populations in any given forest cover type can vary considerably depending on the form and composition of the understory (e.g., McClelland and Bitumount aspen forest plots). An extensive ground truthing program would have to be undertaken before reliable and accurate avifaunal production capability maps could be produced.

However, the importance of assessing the value of various habitats to avifauna was recognized; a tool for management is obviously required. Therefore a habitat evaluation key for the AOSERP area (Appendix 7.16) was devised. The purpose of this key is to provide a means by which habitats can be evaluated without recourse to expensive and time-consuming ornithological studies.

The impact of oil sands and ancillary developments will take two main forms: habitat destruction and alteration; and chemical contamination. The major effects of habitat alteration and destruction are listed below; the effects of chemical contamination were not addressed in this study, but could be quite important. It is strongly recommended that an intensive program of toxicological research be implemented immediately.

Habitat destruction for mining will, in the long term, have two significant effects:

1. The permanent near elimination of water-saturated habitats (muskegs and fens), from the surface mineable area; and
2. A temporary reduction in or near elimination of overmature forests and mature conifers from the surface mineable area. Overmature forests will not be present on reclaimed sites until the late 22nd century.

Eight species of birds (Sandhill Crane, Short-billed Dowitcher, Common Snipe, Wilson's and Palm Warblers, LeConte's, Sharp-tailed and Swamp Sparrows) are restricted to water-saturated habitats. Complete extirpation of the surface mineable deposits will result in permanent near or complete elimination of these species from the surface mineable area. Suitable habitat for all of these species will continue to be present outside the surface mineable area. Nine species of hole-nesting birds (Yellow-bellied Sapsucker, Common Flicker, Pileated, Hairy, Black-back Three-toed and Northern

Three-toed Woodpeckers, Red-breasted Nuthatch, Black-capped and Boreal Chickadees) will be most affected by a lack of overmature forests and mature conifers. Numbers of these species in the surface mineable area may be substantially reduced for a period of up to 200 years. Suitable habitat for all of these species will continue to be available outside the surface mineable area.

For all other indigenous bird species, suitable habitat will be continuously available in the surface mineable area throughout the development period and thereafter.

No assessment can be made at this time of the potential impact of in situ mining of oil sands, as the scale and techniques of such operations are not known.

Impact of cutlines on avifauna is minimal. The creation of edge situations may even have a slight positive effect. Effects of roads will derive mainly from vehicular traffic and the dust clouds typical of unpaved roads.

The impact of townsites will depend on two factors; the value of the habitat on the site, and the thoroughness of clearing operations.

Impact mitigation can be accomplished in several ways:

1. As the utilization by boreal avifauna of introduced plant species has not been studied, it is recommended that native plant species be used for reclamation.
2. It is recommended that jack pine be included as a minor component in all reclaimed areas (for Spruce Grouse) but that it be avoided as a dominant species.
3. It is recommended that speckled alder be used sparingly if at all in reclamation.
4. Spacing of trees at least 8 m apart should result in maximized avifaunal diversity on reclaimed sites (at all seral stages).
5. It is recommended that both deciduous and coniferous trees be reclaimed, as well as berry-producing shrubs,

6. Due to the predominance of excellent bird habitat in general, and overmature forests in particular, in the Athabasca River valley, it is recommended that, whenever possible, roads, townsites and other developments be located so as to avoid this valley.
7. It is recommended that, where possible, enclaves of original habitat (preferably river valleys) be maintained within oil sands leases (e.g., the MacKay River valley on Syncrude Lease #17). Even tiny enclaves will probably result in early recolonization of reclaimed habitats by several bird.
8. It is recommended that habitat destruction and start up of localized and ongoing disturbances occur between 30 July and 15 April, preferably between 30 August and 1 March.
9. It is recommended that as many trees as possible be left standing in townsites, and that enclaves of original habitat be incorporated into the zoning schemes.

5. GLOSSARY

5.1 AVIAN HABITATS

Suitable Habitat: That habitat in which a species breeds at relatively high densities.

Preferred Habitat: That habitat in which a species attains its greatest population.

Optimal Habitat: Refers to either of the above two habitats.

Sub-optimal or Marginal Habitat: That habitat which is occupied only in years of high populations when optimal habitats are saturated. Population densities in sub-optimal habitats are much lower than those in optimal habitats.

5.2 AVIAN POPULATIONS

Total Populations: The combined population density of all species present in a given habitat.

Abundance of Breeding Avifauna: Refers to a high total population.

Species Richness: The total number of species breeding on a given study plot.

Coefficient of Integral Niches (C.I.N.): A measure of the number of species for which a given habitat type is optimal.

Diversity of Breeding Avifauna: Refers to a high species richness or C.I.N.

Substantiated Territory: A breeding territory which is substantiated by the number of bird registrations required by the IBCC standards.

Unsubstantiated Territory: A suspected breeding territory which does not have a sufficient number of bird registrations to meet the IBCC standards but does have a number of observations which suggest the presence of a breeding territory.

5.3 HABITAT DESCRIPTION

Stratum 1: Includes woody stemmed plants less than 0.5 m tall plus all forbs, grasses, sedges and other non-woody plants.

Figure 23. Low deciduous foliage height diversity.

Figure 24. High deciduous foliage height diversity

Figure 25. Low coniferous foliage height diversity.

Figure 26. High coniferous foliage height diversity.

Stratum 2: The shrub or understory stratum which includes all woody stemmed plants between 0.5 and 5 m tall.

Stratum 3: All shrubs and trees taller than 5 m.

Height Diversity: Refers to variation in height of plants within a given stratum.

Uniform Height: Describes a condition in which all trees are much the same height.

Foliage Height Diversity: Refers to the depth of foliage; generally in stands of uniform height. For example, a stand of trees 12 m tall in which the foliage on the trees extends down to within 5 m of the ground exhibits more foliage height diversity than does a stand of trees 12 m tall in which the foliage is all more than 10 m above ground. (See Figures 23, 24, 25 and 26.)

Scattered: The space between the individual plants of the stratum exceeds twice the diameter of the individual plant canopies.

Clumped: The plants of the stratum occur in groups with the space between the collective crowns of the groups exceeding twice the diameter of the individual clumps.

Open: The crowns of the plants of the stratum are separated by spaces at least equal to their diameters but not more than twice their diameters.

Dense: The crowns of the plants of the stratum are separated by spaces up to the equivalent of their diameters.

Closed: The crowns of the plants of the stratum are predominantly touching or overlapping.

5.4 SOIL WATER REGIME

Dry: Well or rapidly drained.

Fresh: Moderately well drained.

Moist: Imperfectly drained.

Wet: Poorly drained.

Saturated: Very poorly drained. Free water remains at or within 30 cm of the surface most of the year.

Hydric: Pertaining to a wet environment.

Mesic: Pertaining to an environment having a balanced water supply.

Xeric: Pertaining to a dry environment.

5.5 HABITAT TYPES

Bog: A peat-covered or peat-filled area, generally with a high water table, dominated by mosses. Although the water table is often close to the surface, usually there is a little standing water. May or may not be tree covered. Bog has been used interchangeably with term muskeg. In general the term bog has been used in this report to mean small areas of open muskegs.

Fen: Grass, sedge or reed-covered peatlands, often with some shrub cover and sometimes a scattered tree layer. Water table at surface most of the time.

Marsh: Grassy, wet places, usually with little peat and much standing or slowly moving water. Cattails and phragmites often abundant. Grass or sedge sods often not consolidated.

Muskeg: Most properly applied to large expanses of sphagnum peatland bearing black spruce and tamarack. Ericaceous shrubs are typically prominent. Water regime similar to the water regime described for a bog.

Peat: Consists largely of organic residues which originated under more or less water saturated conditions through the incomplete decomposition of plant and animal constituents.

Water Saturated Habitats: Term which refers to bogs, fens, marshes, muskegs and swamps.

Swamp: Forested wetlands, usually with shallow peat. Standing or gently flowing water abounds.

Mixed Forest: Refers to a forest which comprises a homogeneous mixture of deciduous and coniferous tree species.

Mixture of Habitats: Refers to an area in which two or more discrete habitats are present (e.g., pine forest and willow scrubland).

Homogeneous Habitat: Refers to the relative absence of variation (of height, density, species composition, etc.) in a habitat.

Habitat Impurities: Variations which diverge from the habitat type being sampled (e.g., a copse of spruce trees in a deciduous forest plot).

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7. APPENDICES

7.1 AN ANNOTATED LIST OF THE BIRDS OF THE AOSERP AREA

7.1.1 Introduction.

This list details the status of 235 bird species in the AOSERP study area. The periods of occurrence, abundance and habitat relationships of these species have been based on information collected during field studies in the fall of 1975 and in 1976 and 1977. An extensive literature search was conducted to supplement this information. The species names have been taken from the Checklist of the American Ornithologists' Union (1937) revision (1976) and their order from the A.B.A. Checklist (1975).

In addition to delineating the abundance and habitat preferences of each species, an attempt has been made to identify the potential impact of oil sands development and the subsequent reclamation of mined areas. In some cases, these effects can be discussed for an entire species group.

Various terms and symbols have been used to describe the status of species occurring within the study area.

Resident: Year-round resident in the area.

Winter Resident: A species which migrates into the area and stays through the winter months (November to March).

Breeds: A summer resident breeding within the study area and whose status is substantiated by nest records and/or the presence of territorial males during the breeding season.

Migrant: A species which passes through the area during migration and is not known to breed in the study area.

Wanderer: A species whose normal breeding range or migration route is outside of the study area.

U: The status or date is unknown. This symbol denotes a status which cannot be substantiated but which is suspected of being representative for the species in question.

A status or date followed by one of the symbols listed below indicates that the information came from one of the following sources:

B: Beaver (1977).

G: Godfrey (1966).

S: Salt and Salt (1976).

SR: Sharp and Richardson (1976).

W: Ward, Dyke and Sharp (1976).

There has been no attempt to create categories which describe the abundance of a species. Instead we have included the actual plot data and in some cases subplot data in order to provide a more accurate assessment of species abundance in various habitats.

The terms used in describing habitat preferences are taken from the instructions for habitat quantification (Appendix 7.13).

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Chestnut-collared Longspur (wanderer) 250
Snow Bunting (migrant) 250

7.1.3 Annotated list

7.1.3.1 Loons.

Common Loon (*Gavia immer*)

Spring Arrival: 1 May

Fall Departure: 30 September

Status: Breeds

The Common Loon, a picivorous species, requires that waterbodies, which are utilized for breeding, support an abundant fish population. Any fish species that can be captured and swallowed by a Loon may serve as prey (Olson and Marshall 1952). Moderate-sized lakes, when occupied, have 1 resident pair while larger lakes such as McClelland Lake may have 2 to 4 pairs breeding. Loons actively defend territories against other loons (Olson and Marshall 1952). The nest is usually located on an island, beaver lodge, or floating vegetation mat. The density and type of vegetation at the nest site do not appear to be critical. During a 1976 survey of 65 selected oil sands wetlands, 130 Loons were observed. The creation of tailing ponds represents the largest potential impact of the tar sands industry. The large expanses of open water provided by tailings ponds resemble ideal resting areas (especially during the spring when natural waterbodies are frozen over) and, therefore, require adequate deterrent mechanisms. Not only do Loons defend their territories against other Loons, but also against human intrusion. Consequently excessive human activity around nesting birds may so disrupt their breeding activity that the nest may be either deserted or depredated while the adults are defending the territory.

Arctic Loon (*Gavia arctica*)

Status: Migrant?

Although the Artic Loon has not been observed by project personnel, its presence as breeder in extreme northern Alberta (Salt and Salt 1976) would suggest that it occurs as a migrant through the study area. However its occurrence would be minimal.

Red-throated Loon (*Gavia stellata*)

Spring Arrival: U

Fall Departure: U

Status: Migrant - S

The Red-throated Loon has been recorded as a migrant in northern Alberta (Salt and Salt 1976).

7.1.3.2 Grebes.

Red-necked Grebe (*Podiceps grisegena*)

Spring Arrival: 21 April

Fall Departure: 1 October

Status: Breeds

The Red-necked Grebe can utilize a variety of emergent vegetation types for nesting (e.g., cattails, rushes, sedges and bushes) and consequently is found breeding on a wide variety of lakes and marshes throughout the study area. The Red-necked Grebe is also able to utilize a wide variety of food sources [e.g., small fish, aquatic and land insects and larvae, tadpoles, salamanders, crustaceans, mollusks and aquatic worms (Palmer 1962)]. This species may be colonial. During 1977 aerial surveys of McClelland Lake, a colony of 15 pairs was observed using an areas of *Scirpus*, approximately 75 x 50 m, for nesting. In addition to the colonial nesting pairs, 10 to 20 pairs nested around the perimeter of the lake. The loss of the small marshes and lakes, destroyed during the clearing operations conducted by GCOS and Syncrude, did not affect the overall population. However, important lakes such as McClelland Lake should not be tampered with. Tailings ponds pose a major threat to migrating birds. During spring, any tailings pond with living or dead emergent vegetation may attract birds because these represent potential nesting sites. During migration the Red-necked Grebe is quite gregarious (Palmer 1962) and any oil-soaked birds present on a tailings pond could easily attract more birds. The Red-necked Grebe usually migrates at night which further increases the chances of it accidentally landing on a tailings pond. Adequate deterrent mechanisms are needed for this species.

Horned Grebe (*Podiceps auritus*)

Spring Arrival: 1 May

Fall Departure: 8 October

Status: Breeds

The Horned Grebe utilizes marshes and lakes throughout the area and will construct a nest within a zone of emergent vegetation, usually in shallow water. It utilizes 99% animal food during all months (Palmer 1962). The Horned Grebe is not abundant in the study area; only 2 birds of this species were observed during spring migration surveys.

Eared Grebe (*Podiceps nigricollis*)

Spring Arrival: 9 May

Fall Departure: U

Status: Breeds

The Eared Grebe bred at Birch Lake during 1977 (R. Beaver pers. comm. 1978), but has not been recorded as a breeding species anywhere else.

Western Grebe (*Aechmophorus occidentalis*)

Spring Arrival: U

Fall Departure: U

Status: Breeds - G

There have been sporadic sightings of the Western Grebe along the Athabasca River and in the Peace-Athabasca Delta. Project personnel have not found any evidence of this species breeding in the area. Five individuals were observed on Birch Lake during the spring of 1977 (M. Ballantyne pers. comm.)

Pied-billed Grebe (*Podilymbus podiceps*)

Spring Arrival: 17 May

Fall Departure: 28 September

The Pied-billed Grebe breeds throughout the area on lakes and marshes which have an abundance of emergent vegetation. This species is a nocturnal migrant (Palmer 1962).

White Pelican (*Pelecanus erythrorhynchos*)

Spring Arrival: 22 April

Fall Departure: 30 September

Status: Breeds

The one active breeding colony in the area utilized an island in Birch Lake during 1976 and 1977 as its nesting site. An island in Namur Lake has been an alternate nesting site. The colony in 1976 numbered 140 pairs and raised 68 young (Beaver and Ballantyne 1977). Pelicans forage on a number of lakes in the Birch Mountain area. Pelicans also have been observed foraging on the east side of the Athabasca River. These birds probably represent a group of wandering non-breeders. The remoteness of the nesting island is very important in determining the success of the breeding adults. Young pelicans are helpless during the first 3 to 4 weeks and if parent birds are scared off the nests the young birds are in danger of being killed by gulls or by excessive exposure to the elements. The adult birds will remain on the open water until they feel it is safe to come back. Therefore industrial and recreational development must be planned in such a way that the isolation of breeding colonies is maintained.

Double-crested Cormorant (*Phalacrocorax auritus*)

Spring Arrival: 13 May

Fall Departure: U

Status: Wanderer

During 1976 and 1977 the Double-crested Cormorant was observed at Birch Lake (B. Beaver pers. comm. 1978).

1977 Birch Lake observations:

13 May	11 adults
15 May	1 adult
26 May	8 adults
12 June	1 adult

Great Blue Heron (*Ardea herodias*)

Spring Arrival: 8 May

Fall Departure: 16 September

Status: Breeds - S

The Great Blue Heron has been reported to breed along the south shore of Lake Athabasca (Salt and Salt 1976). However, observations of this species were limited during 1976 and 1977 and this tends to indicate that the breeding populations are small.

American Bittern (*Botaurus lentiginosus*)

Spring Arrival: 18 May

Fall Departure: U

Status: Breeds - C

This species has been observed at a number of different locations throughout the area. It prefers lakes and marshes with wet meadow zones and shallow water areas for feeding and nesting.

7.1.3.3 Swans and Geese. The impact of the oil sands development will be essentially the same for all the species of geese migrating through the study area. The impact on migrating geese is expected to be minimal, however adequate tailings pond deterrents are still required. Data collected so far tend to support the theory that the southern portion of the study area is not widely utilized by migrating geese as a staging or stop-over area. Large concentrations of geese do use the Peace-Athabasca Delta as a staging area before they fly south to the prairie region. Because of the small population of Canada Geese breeding within the study area, the impact of oil sands development on breeding geese is not of major concern.

Whistling Swan (*Olor columbianus*)

Spring Arrival: 28 April

Spring Departure: 14 July

Fall Arrival: 1 September

Fall Departure: 3 November

Status: Migrant

The Whistling Swan is a common migrant through the area and will make rest stops on lakes, and sandbars in the Athabasca River.

Canada Goose (*Branta canadensis*)

Spring Arrival: 28 April

Fall Departure: late October

Status: Breeds - G

During spring and fall migration, large numbers of Canada Geese migrate through the area. Spring migration can be divided into two separate periods. The first wave of migrating birds is formed by birds heading north to breed while the smaller second wave is formed by non-breeding birds (Sterling and Dzubin 1967). The presence of breeding Canada geese in the study area is suspected, however there have been no observations of broods within the study area. An unsuccessful nesting attempt was made by a pair on McClelland Lake during 1976. Information gathered from residents of the area suggests that McClelland Lake was a traditional nesting area for Canada Geese but in recent years water levels have risen on the lake and flooded out the available nesting cover.

Brant (*Branta bernicla*)

Status: Wanderer - W

This species does not normally migrate inland; however, on 13 September 1975, three Brant were sighted on Syncrude Lease 17 (Ward et al. 1976).

White-fronted Goose (*Anser albifrons*)

Spring Arrival: 28 April

Spring Departure: 8 May

Fall Arrival: 8 August

Fall Departure: late October

Status: Migrant

Large numbers of White-fronted Geese migrate through the study area, however only the Peace-Athabasca Delta is important as a stop-over or staging area.

Snow Goose (*Chen caerulescens*)

Spring Arrival: 10 May

Spring Departure: 27 May

Fall Arrival: 15 September

Fall Departure: late October

Status: Migrant

The Snow Goose migrates through the study area in large numbers.

Ross' Goose (*Chen rossii*)

Spring Arrival: U

Spring Departure: U

Fall Arrival: 15 September

Fall Departure: U

Status: Migrant

Due to difficulties in identifying this species, the exact abundance of the Ross' Goose is not known.

7.1.3.4 Ducks.

Mallard (*Anas platyrhyncos*)

Spring Arrival: early April

Fall Departure: 30 October

Status: Breeds

The Mallard, which breeds throughout the study area, is the most commonly occurring of the dabbling ducks. Breeding pairs are associated with a wide variety of wetland habitats, however certain preferences have become evident from the analysis of survey data. Emergent vegetation next to a shrub zone or next to a wet meadow zone appears to be the preferred habitat for this species. Back-dating of brood observations of Mallards suggests that nesting begins as early as 1 April and for the most part is terminated by the end of the second week of June. Between 150 and 200 broods per 500 km of shoreline are the expected densities of Mallard broods in the study area. Brood sizes in 1976 averaged 5.5 ducklings per brood.

During the 1976 fall migration, two peaks in Mallard numbers, one during the period of 19 to 20 August and the other during 8 to 9, October were noted. Northern nesting birds arrive in the study area during late fall.

Black Duck (*Anas rubripes*)

Status: Wanderer

A Black Duck, which was later recovered in the State of Mississippi, was banded on the Peace-Athabasca Delta (Hennan 1972). This is apparently the only record of this species within the area.

Gadwall (*Anas strepera*)

Spring Arrival: 28 April

Fall Departure: late September

Status: Breeds

Within the study area, the greatest densities of breeding Gadwalls can be expected in the Peace-Athabasca Delta (Salt and Salt 1976). Gadwall have been observed throughout the study area but never in significant numbers. The breeding range of this species mostly lies south of the study area (Salt and Salt 1976).

Pintail (*Anas acuta*)

Spring Arrival: 22 April

Fall Departure: mid-October

Status: Breeds

The Pintail breeds throughout the study area but at relatively low densities (i.e., less than 10 broods per 500 km). During the 1976 fall migration, Pintail numbers were highest during the period of 19 to 20 August. Residents and summer moulters leave during August.

Green-winged Teal (*Anas crecca*)

Spring Arrival: 1 May

Fall Departure: 8 October

Status: Breeds

The Green-winged Teal breeds throughout the study area and is probably the most common of the teal species.

Blue-winged Teal (*Anas discors*)

Spring Arrival: 2 May

Fall Departure: 8 October

Status: Breeds

Less common that the Green-winged Teal, the Blue-winged Teal breeds throughout the area.

Cinnamon Teal (*Anas cyanoptera*)

Status: Wanderer

The Cinnamon Teal, whose normal breeding range is well south of the study area, has been observed once within the area.

McClelland Lake, 1 June 1976, 1 pair.

American Widgeon (*Anas americana*)

Spring Arrival: 4 May

Fall Departure: 8 October

Status: Breeds

The American Widgeon breeds throughout the area.

Northern Shoveler (*Anas clypeata*)

Spring Arrival: 6 May

Fall Departure: 8 October

Status: Breeds

The Shoveler breeds throughout the area.

Redhead (*Aythya americana*)

Spring Arrival: 2 May

Fall Departure: 23 October

Status: Breeds - G

Breeding Redheads are not abundant within the area. Birds arrive from the north in early September and some remain until late fall. Large flocks of staging Redheads have been observed on McClelland Lake.

Ring-necked Duck (*Aythya collaris*)

Spring Arrival: 8 May

Fall Departure: 9 October

Status: Breeds

The Ring-necked duck breeds throughout the area. Resident birds linger within the area after the breeding season and are joined by northern birds. The majority of these birds leave by late September but a few individuals remain as long as open water is present.

Canvasback (*Aythya valisneria*)

Spring Arrival: 1 May

Fall Departure: 23 October

Status: Breeds

The Canvasback breeds throughout the area but not in great numbers. There is a build-up of northern birds from late August through mid-September. The majority depart by late September.

Greater Scaup (*Aythya marila*)

Status: Wanderer - W

A rare migrant in Alberta. Three Greater Scaup were identified on 23 October 1975 (Ward et al. 1976). Due to the difficulty of distinguishing between Greater and Lesser Scaup in field conditions the exact status of Greater Scaup is hard to determine. It has been suggested that there is a fall migration route through northeastern Alberta (Bellrose 1976).

Lesser Scaup (*Aythya affinis*)

Spring Arrival: 3 May

Fall Departure: 3 November

Status: Breeds

The Lesser Scaup is a common breeder throughout the area. From the analysis of breeding pair data it has been determined that emergent vegetation next to a shrub zone or next to a wet meadow zone is preferred by breeding Lesser Scaup. Birds will linger in the area until freeze-up.

Common Goldeneye (*Bucephala clangula*)

Spring Arrival: 2 May

Fall Departure: 3 November

Status: Breeds

The Common Goldeneye breeds throughout the area. This species requires natural nesting cavities such as woodpecker holes. Resident birds are joined by northern breeders during early September and a small number will remain within the area until freeze-up.

Bufflehead (*Bucephala albeola*)

Spring Arrival: 25 April

Fall Departure: 3 November

Status: Breeds

The Bufflehead breeds throughout the area and requires woodpecker holes for nesting. Resident birds and summer moulters leave the area by mid-September. Northern birds will remain until early November.

Oldsquaw (*Clangula hyemalis*)

Spring Arrival: U

Fall Departure: U

Status: Migrant

The Oldsquaw appears to be a rare spring migrant through the area. The Oldsquaw may occur more commonly in the Birch Mountains.

McClelland Lake	24 May 1976	4 adults	Palindat/Hennan
Fishtail Lake	27 May 1977	1 adult	Lumbis
Birch Mountains	R. Beaver reports that he sighted several individuals during spring migration in 1976 and 1977.		

Harlequin Duck (*Histrionicus histrionicus*)

Status: Wanderer

During June 1977, a male in full breeding plumage was identified on a tributary of the Muskeg River. The bird was observed through binoculars while it was swimming below a set of small rapids (Steve McGovern pers. comm. 1977).

White-winged Scoter (*Melanitta deglandi*)

Spring Arrival: 13 May

Fall Departure: 8 October

Status: Breeds - G

The White-winged Scoter is the most commonly observed scoter within the area. Larger lakes such as McClelland or Kearl are important stop-over lakes during migration. Project personnel have not observed the White-winged Scoter breeding on any of the lakes surveyed within the area.

Surf Scoter (*Melanitta perspicillata*)

Spring Arrival: 13 May

Fall Departure: 8 October

Status: Breeds - G

The Surf Scoter is not an abundant species within the area. We have no records of this species breeding in the area.

Black Scoter (*Melanitta nigra*)

Spring Arrival: U

Fall Departure: U

Status: Wanderer

Although the sightings of the Black Scoter in the area have not been substantiated by photographs, the sightings were made under favourable conditions. The 1976 sightings on McClelland Lake were made after a storm front passed through the area. The Kearl Lake specimen was observed during a boat survey and an aerial survey on a later date.

McClelland Lake	1 June 1976	7 adults	Palindat/Hennan
McClelland Lake	9 June 1976	4 adults	Palindat
Athabasca River (Fort McKay)	24 May 1977	4 adults	Francis/Lumbis
Kearl Lake	27 May 1977	1 adult	Lumbis/Fairbarns

Ruddy Duck (*Oxyura jamaicensis*)

Spring Arrival: 16 May

Fall Departure: 28 September

Status: Breeds

The Ruddy Duck breeds in the area however it is not an abundant species. Broods have been reported on Birch Lake (R. Beaver pers. comm. 1977). Relatively large fall migration flocks have been observed on McClelland Lake.

Hooded Merganser (*Lophodytes cucullatus*)

Status: Wanderer

There have been two sightings of this species in the area.

McClelland Lake	11 September 1976	3 adults	Palindat
Birch Lake	date unknown	3 individuals	D. Richards

Common Merganser (*Mergus merganser*)

Spring Arrival: 12 April

Fall Departure: 18 September

Status: Breeds

This species breeds on rivers and streams in which good fish populations are present, such as Hartley Creek and the Muskeg and Firebag rivers. These birds also forage on lakes, particularly during migration.

Red-breasted Merganser (*Mergus serrator*)

Spring Arrival: 1 May

Fall Departure: 12 September

Status: Breeds - G

This species has only been recorded as a migrant through the area.

7.1.3.5 Accipiters, Buteos, and Eagles.

Goshawk (*Accipiter gentilis*)

Status: Resident

The Goshawk breeds throughout the study area and has been observed in a variety of forested habitats. This species has a

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preference for coniferous-dominated forests and has been seen in a variety of habitats, ranging from dry, open, jack pine forests to dense spruce muskegs.

Sharp-shinned Hawk (*Accipiter striatus*)

Spring Arrival: 6 May
Fall Departure: 23 September
Status: Breeds

Found in a variety of mixed-forest habitats, the Sharp-shinned Hawk breeds throughout the study area. Adults and fledged young were observed on the Hartley Creek plot during August 1977. This species is most frequently observed along cutlines, roads, airstrips, clearings and rivers, especially during the migration periods. Sharp-shinned Hawks have been observed hunting Lapland Longspurs in open areas. Spring and fall migrations suggest that the Athabasca River valley may be an important migration route.

Cooper's Hawk (*Accipiter cooperii*)

Status: Wanderer

Infrequent sightings of Cooper's Hawk suggest that its occurrence in the study area is very sporadic.

Red-tailed Hawk (*Buteo jamaicensis*)

Spring Arrival: 7 April
Fall Departure: 25 September
Status: Breeds - G

This species, which is frequently observed during spring and fall migration, has seldom been observed during the summer months. Red-tailed Hawks were reported breeding near Ruth Lake (Sharp and Richardson 1976), however the total breeding population within the study area must be relatively small.

Broad-winged Hawk (*Buteo platypterus*)

Spring Arrival: 15 May
Fall Departure: 4 September
Status: Breeds

The Broad-winged Hawk is often seen along cutlines in aspen-dominated forests and has been observed breeding in similar habitat. A nesting territory of this species included a portion of the Bitumount aspen plot. A nest was not actively searched for but a young of year was observed.

Swainson's Hawk (*Buteo swainsoni*)

Spring Arrival: U

Spring Departure: U

Fall Arrival: U

Fall Departure: U

Status: Migrant

One observation of a Swainson's Hawk in June 1976 constitutes our only observation, and consequently this species must be considered a rare migrant through the study area. Migrants through the study area would be flying towards breeding grounds in Alaska, the Yukon, and the Northwest Territories (Godfrey 1966).

Rough-legged Hawk (*Buteo lagopus*)

Spring Arrival: 14 March

Spring Departure: U

Fall Arrival: 24 September

Fall Departure: 13 November

Status: Migrant

The Rough-legged Hawk breeds in the arctic (Godfrey 1966). During migration, this hawk is commonly observed throughout the area, most often in association with the more open habitats.

Golden Eagle (*Aquila chrysaetos*)

Spring Arrival: 9 May

Fall Departure: late October

Status: Breeds - B

Although the normal breeding range has been described as including the study area (Salt and Salt 1976), surveys conducted within the study area suggest that the Golden Eagle is restricted to the Precambrian Shield area. During surveys conducted in 1976, one productive and ten unoccupied possible Golden Eagle eyries were observed (Beaver 1977). Although this species occasionally nests in trees, it prefers to nest on cliffs (Salt and Salt 1976) and consequently prefers the shield area.

Bald Eagle (*Haliaeetus leucocephalus*)

Spring Arrival: early April

Fall Departure: 3 November

Status: Breeds

The Bald Eagle occurs mainly in the shield area although there are breeding birds in the Birch Mountains. The nest is generally located in a tall tree in close proximity to a lake. In 1976 there were 18 productive nests sites and eight non-productive occupied sites found during censuses of the area (Beaver 1977). The fall departure date is variable and is largely dependent on the presence of open water and waterfowl or the presence of carrion.

Marsh Hawk (*Circus cyaneus*)

Spring Arrival: 31 March

Fall Departure: 3 October

Status: Breeds - G

Although no nests were found, it is assumed from the observations of Marsh Hawks in the study area that they nest in the more open muskegs and marshes. This raptor is widely distributed over the study area.

Osprey (*Pandion haliaetus*)

Spring Arrival: U

Fall Departure: U

Status: Breeds - B

The Osprey is a rare bird in the area. During surveys conducted in 1976, five breeding pairs were observed (Beaver 1977).

7.1.3.6 Falcons.

Gyrfalcon (*Falco rusticolus*)

Spring Departure: U

Fall Arrival: 4 October - SR

Status: Migrant

The Gyrfalcon, which nests in the arctic regions, may wander south during the winter to the prairies (Salt and Salt 1976). The Gyrfalcon prefers non-forested areas and consequently the lack of this type of habitat means there is little incentive for this species to stay within the study area. The Peace-Athabasca Delta may be a more attractive area for this species.

Peregrine Falcon (*Falco peregrinus*)

Spring Arrival: 2 May
Fall Departure: 5 October
Status: Breeds

The Peregrine Falcon breeds in the northern portion of the study area. The nest site will be located on a high, inaccessible cliff. A limited number of observations suggests that the Athabasca River valley may be an important migration corridor for this species.

Merlin (*Falco columbarius*)

Spring Arrival: 14 April
Fall Departure: 21 September - SR
Status: Breeds - G

Observations of Merlins by project personel have been infrequent. A number of observations near Syncrude Lower Camp suggested the presence of a pair (Sharp and Richardson 1976). The breeding range of the Merlin includes the study area and also extends well north of it (Godfrey 1966).

American Kestrel (*Falco sparverius*)

Spring Arrival: 13 April
Fall Departure: 21 September - SR
Status: Breeds

The Kestrel breeds throughout the study area in open, mature forests and along forest edge situations. Mature forests along rivers, cutlines or clearings are favoured habitats. The Kestrel nests in cavities, usually in woodpecker holes but sometimes in cavities in earth faces.

Mature balsam poplar/scrub willow plot 2 territories/100 ha.

7.1.3.7 Grouse.

Spruce Grouse (*Canachites canadensis*)

Status: Resident

The Spruce Grouse is found throughout the study area and breeds in a variety of coniferous-dominated habitats, from dry, young jack pine stands to wet, mature black spruce muskegs. Of the three species of upland gamebirds in the study area, the Spruce Grouse is most common. A shift in habitat preferences has been noted during the fall and winter. An emigration from habitats with no jack pine to habitats with jack pine has been suggested by our data. This shift in habitat selection represents a change in diet (e.g., berries during summer, jack pine needles during winter).

Bitumount aspen plot	0.04
Aspen-jack pine plot	0.22
Young jack pine plot	0.14
Young mixed forest plot	0.46
Mature mixed forest plot	0.04
River transect	0.03
Hartley Creek valley plot	0.25
Interface plot	0.42
Young black spruce plot	0.10
Mature black spruce plot	0.32
Bitumount muskeg plot (1976)	0.28
Bitumount muskeg plot (1977)	0.24

Ruffed Grouse (*Bonasa umbellus*)

Status: Breeds

The Ruffed Grouse breeds throughout the study area in deciduous and mixed forests which have substantial shrub understories. Shrubs provide excellent cover and various food sources during the summer as well as providing buds and twigs during the winter. Drumming sites are usually more open than brood habitat.

Bitumount aspen plot	0.32
McClelland aspen plot	0.13
Aspen-jack pine plot	0.02

Young mixed forest plot	0.05
Mature mixed forest plot	0.19
River transect	0.14
LaFont Island	0.27
Hartley Creek valley plot	0.45
Interface plot	0.03
Tall bottomland willow plot	0.46
Young black spruce plot	0.02

Willow Ptarmigan (*Lagopus lagopus*)

Spring Departure: early April

Fall Arrival: late November

Status: Winter migrant

The abundance of Willow Ptarmigan in the study area during the winter is variable and is probably dependent on the severity of the winter in this species' northern summer range. Willow Ptarmigan species can be found in a number of habitats, but prefer areas with an abundance of shrubs, especially willow, upon which they can feed.

Sharp-tailed Grouse (*Pedioecetes phasianellus*)

Status: Resident

The Sharp-tailed Grouse occurs sporadically throughout the study area and has been observed in a variety of habitats. Several observations of adults and one of a brood have been made near the Mildred Lake AOSERP camp. Dancing grounds were situated on two of the breeding bird plots sampled during 1977. One dancing ground was located on an open bog birch muskeg while the other was situated on an open muskeg dominated by bog birch and with a scattered canopy of tamarack. The males were observed dancing on the moss hummocks.

7.1.3.8 Cranes.

Whooping Crane (*Grus americana*)

Spring Arrival: late April

Fall Departure: early September

Status: Migrant

This species nests in the Wood Buffalo National Park. Periodic sightings are made of Whooping Cranes migrating through the area and occasionally of birds stopping over in the area.

Sandhill Crane (*Grus canadensis*)

Spring Arrival: 13 April

Fall Departure: 2 October

Status: Breeds

This species is found throughout the area and prefers muskegs and marshes for breeding habitat. It forages in a wide variety of habitats, including cutlines.

Bitumount muskeg plot	1 territory/100 ha
Bitumount muskeg plot	1 "
Tamarack muskeg plot	2 "

7.1.3.9 Rails, Coots.

Virginia Rail (*Rallus limicola*)

Spring Arrival: U

Fall Departure: U

Status: Breeds - G

One bird was heard and observed in a *Carex-Typha latifolia* marsh on 23 June 1977.

Sora (*Porzana carolina*)

Spring Arrival: 13 May

Fall Departure: 15 September

Status: Breeds

This species is found throughout the area and will breed on any water body that has a zone of dense sedges or grasses. Nests are usually located in grasses or sedges a short distance from the water's edge. Soras will also breed in sedge fens which have small pools of open water.

Sedge fen plot	68 territories/100 ha

Yellow Rail (*Coturnicops noveboracensis*)

Spring Arrival: U

Fall Departure: U

Status: Breeds - G

A bird heard in a *Betula pumila-Carex* spp. fen on 26 May 1977 constitutes our only observation of this species.

American Coot (*Fulica americana*)

Spring Arrival: 27 April

Fall Departure: 29 September

Status: Breeds

This species is common throughout the area and breeds on water bodies that have zones of emergent vegetation. Floating nests are anchored to the emergent vegetation. American Coots migrate at night and thus may be susceptible to accidentally landing on tailings ponds.

7.1.3.10 Shorebirds. Within the AOSERP study area, the diversity and abundance of breeding shorebird species are less than the diversity and abundance of species which migrate through the study area. As such, the potential impact of oil sands development is greatest on migrating shorebirds. The clearing of muskegs creates moist, open mudflats which provide shorebirds with an attractive rest area. This in itself is not a dangerous situation, however the close proximity of tailings ponds to these cleared areas could be very deleterious to this group of birds. As tailings ponds are an unavoidable concomitant of the present oil sands operations, every effort should be made to minimize their effects. The banks of tailings ponds should be constructed so that a very steep face is produced, thereby providing unattractive rest areas for shorebirds. Secondly, the filling of a tailings pond should be conducted so that shallow water areas are not created. This can be accomplished by building small cells within the main tailings pond area and rapidly filling each cell to a depth of approximately 0.3 m. Once the total basin has been flooded, shorebirds will find this depth unattractive and should avoid the tailings pond area. Phalaropes are the only group of shorebirds which regularly land on open water. Scare tactics employed for waterfowl may be effective on these birds.

American Avocet (*Recurvirostra americana*)

Status: Breeds

During 1977, R. Beaver reported that two pairs of American Avocets attempted to breed on the Pelican rookery island. The birds were observed copulating, however there was no evidence of nest construction. These birds were last observed at the end of June. Soper (1942) includes a record of Preble (1908) who records two specimens from Chipewyan. During the spring of 1977, three pairs of Avocets were observed on the Syncrude site and subsequently two clutches and one brood were observed. During 1978, two pairs, one lone adult and one brood of two young were observed (Keith Yonge, pers. comm. 1978).

Semipalmated Plover (*Charadrius semipalmatus*)

Spring Arrival: 30 April - SR
Spring Departure: 13 May - SR
Fall Arrival: 16 July - SR
Fall Departure: 8 September - SR
Status: Migrant

The Semipalmated Plover has been frequently observed along the Athabasca River during migration.

Killdeer (*Charadrius vociferus*)

Spring Arrival: 12 April
Fall Departure: 20 September
Status: Breeds

The Killdeer breeds in open areas and is attracted to clear-cut areas such as the GCOS and Syncrude sites, especially to wet areas, such as mud flats, or to drier areas with low ground cover.

American Golden Plover (*Pluvialis dominica*)

Spring Arrival: 13 May - SR

Spring Departure: U

Fall Arrival: U

Fall Departure: U

Status: Migrant

The American Golden Plover is not an abundant migrant through the area.

Black-bellied Plover (*Pluvialis squatarola*)

Spring Arrival: 13 May

Spring Departure: U

Fall Arrival: 8 August - SR

Fall Departure: 19 September

Status: Migrant

The Black-bellied Plover migrates through the area and makes rest stops along cutlines, muskegs and marshes.

Hudsonian Godwit (*Limosa haemastica*)

Status: Migrant

The Hudsonian Godwit is described as being a regular migrant but occurring in small numbers in the eastern half of Alberta during migration from arctic breeding grounds (Salt and Salt 1976).

Whimbrel (*Numenius phaeopus*)

Spring Arrival: U

Spring Departure: U

Status: Migrant

The Whimbrel is described as a scarce spring transient in Alberta (Salt and Salt 1976). One Whimbrel was observed and photographed at Mildred Lake on 30 May 1975 (Sharp and Richardson 1976).

Upland Sandpiper (*Bartramia longicauda*)

Spring Arrival: 13 May

Fall Departure: 26 September - SR

Status: Breeds - G

The Upland Sandpiper has been observed on a few occasions within the area and has not been observed to breed.

Greater Yellowlegs (*Tringa melanoleuca*)

Spring Arrival: 11 April

Fall Departure: 25 October - SR

Status: Breeds

The Greater Yellowlegs breeds throughout the study area and in undeveloped areas typically breeds in muskeg and marsh habitats. The nest is not usually located in the wet areas but instead is situated on a ridge in open woods (Salt and Salt 1976). The Greater Yellowlegs will also utilize disturbed areas as breeding habitat. The Syncrude site was reported to have at least 20 pairs breeding during 1975 (Sharp and Richardson 1976).

Sedge fen plot	11	territories/100 ha
Young black spruce plot	1	"
Bitumount muskeg plot (1976)	3	"
Bitumount muskeg plot (1977)	3	"
Tamarack muskeg plot	1	"

Lesser Yellowlegs (*Tringa flavipes*)

Spring Arrival: 19 April

Fall Departure: 18 October - SR

Status: Breeds

The Lesser Yellowlegs breeds throughout the study area and is apparently less common that the Greater Yellowlegs in undisturbed habitats. In undisturbed habitats, the Lesser Yellowlegs has similar requirements as the Greater Yellowlegs. In disturbed habitats, such as the Syncrude site, Lesser Yellowlegs may be more common. At least 29 pairs nested on this site during 1975 (Sharp and Richardson 1976).

Open bog plot	3	territories/100 ha

Solitary Sandpiper (*Tringa solitaria*)

Spring Arrival: 8 May - SR

Fall Departure: late August

Status: Breeds

The Solitary Sandpiper occurs in small numbers and breeds in open black spruce muskegs, along cutlines and around small woodland marshes. It prefers forested areas which have a substantial percentage of black spruce.

Spotted Sandpiper (*Actitis macularia*)

Spring Arrival: 12 May

Fall Departure: 20 September - SR

Status: Breeds

The Spotted Sandpiper is a common shorebird throughout the area and is found along rivers and streams and to a lesser extent along lakeshores. A littoral zone of some sort is necessary to this species.

LaFont Island	4	territories/100 ha
Mature balsam poplar/scrub willow	1	"
Hartley Creek Valley plot	6	"

Ruddy Turnstone (*Arenaria interpes*)

Spring Arrival: 25 May - SR

Spring Departure: U

Fall Arrival: U

Fall Departure: 4 September - SR

Status: Migrant

The Ruddy Turnstone, an uncommon migrant, migrates through the study area on its way to arctic breeding grounds. Ruddy Turnstones have been observed twice on the Syncrude site (Sharp and Richardson 1976) and once at Namur Lake.

Wilson's Phalarope (*Steganopus tricolor*)

Spring Arrival: 7 May - SR

Fall Departure: 21 August - SR

Status: Breeds

The previously reported breeding range of the Wilson's Phalarope is south of the study area, however it is now known that this species nests within the study area. During 1976, Palindat observed this species breeding at McClelland Lake. They were present at Birch Lake during the summer of 1977 (R. Beaver, pers. comm. 1977). A young of year was observed on the Syncrude site (Sharp and Richardson 1976). The Wilson's Phalarope typically breeds in sloughs, marshes and shallow lakes.

Northern Phalarope (*Lobipes lobatus*)

Spring Arrival: 8 May

Spring Departure: U

Fall Arrival: 2 July - SR

Fall Departure: 25 August - SR

Status: Migrant

The Northern Phalarope passes through the study area on its way to northern breeding grounds. During its passage through the study area, it makes rest stops on the open water of marshes and lakes.

Common Snipe (*Capella gallinago*)

Spring Arrival: 27 April

Fall Departure: 6 October

Status: Breeds

The Common Snipe breeds throughout the study area in a variety of marsh and muskeg habitats. Habitats in which sedges and grasses provide dense ground cover will be used as breeding habitat. Shrub cover does not necessarily exclude the Common Snipe from a habitat, however habitats which are dominated by shorter shrubs (i.e., less than 1.5 m) seem to be more suitable than habitats dominated by tall shrubs.

Tall bottomland willow plot	4	territories/100 ha
Deciduous shrub fen plot	12	"
Open bog plot	9	"
Young black spruce plot	1	"
Bitumount muskeg plot (1976)	3	"
Bitumount muskeg plot (1977)	3	"
Tamarack muskeg plot	2	"

Short-billed Dowitcher (*Limnodromus griseus*)

Spring Arrival: 8 May

Fall Departure: early September

Status: Breeds

The Short-billed Dowitcher breeds locally from Edmonton, north to Great Slave Lake (Godfrey 1966). This species bred on the tamarack muskeg plot, an area dominated by swamp birch and scattered 3 m tall tamarack. Moss hummocks were present and the water table was present at the soil surface, often creating small pools between hummocks.

Tamarack muskeg plot	4 territories/100 ha

Long-billed Dowitcher (*Limnodromus scolopaceus*)

Spring Arrival: 15 May

Spring Departure: U

Fall Arrival: 4 July - SR

Fall Departure: 28 September - SR

Status: Migrant

The Long-billed Dowitcher migrates through the study area on its way to breeding grounds in the arctic. Its abundance during migration is not known.

Sanderling (*Calidris alba*)

Spring Arrival: U

Spring Departure: U

Fall Arrival: 30 July - SR

Fall Departure: 16 September - SR

Status: Migrant

The Sanderling nests in the arctic (Godfrey 1966) and has utilized sandbars in the Athabasca River as resting areas during migration. The Syncrude site was also utilized as a rest area (Sharp and Richardson 1976).

Semipalmated Sandpiper (*Calidris pusilla*)

Spring Arrival: 8 May - SR

Spring Departure: 24 May - SR

Fall Arrival: 2 July - SR

Fall Departure: 14 September - SR

Status: Migrant

The Semipalmated Sandpiper is a common migrant through the study area as it migrates to and from arctic breeding grounds.

Least Sandpiper (*Calidris minutilla*)

Spring Arrival: 8 May - SR

Spring Departure: 31 May - SR

Fall Arrival: 26 June - SR

Fall Departure: 10 September - SR

Status: Migrant

The Least Sandpiper migrates through the study area on its way to and from northern breeding grounds.

White-rumped Sandpiper (*Caladris fuscicollis*)

Status: Wanderer

The White-rumped Sandpiper is described as a rare transient in Alberta (Salt and Salt 1976). Two observations of White-rumped Sandpipers occurred on the Syncrude site (Sharp and Richardson 1976).

Baird's Sandpiper (*Calidris bairdii*)

Spring Arrival: 17 May - SR

Spring Departure: 31 May - SR

Fall Arrival: 4 July - SR

Fall Departure: 14 September - SR

Status: Migrant

The Baird's Sandpiper migrates through the study area on its way to and from arctic nesting grounds.

Pectoral Sandpiper (*Calildris melanotos*)

Spring Arrival: 17 May - SR

Spring Departure: 8 June - SR

Fall Arrival: mid-July

Fall Departure: 24 October - SR

Status: Migrant

The Pectoral Sandpiper migrates through the study area on its way to and from arctic nesting grounds.

Dunlin (*Calidris alpina*)

Status: Wanderer

In Alberta the Dunlin is a rare transient most commonly seen in spring (Salt and Salt 1976). The Dunlin has been observed twice on the Syncrude site (Sharp and Richardson 1976).

Stilt Sandpiper (*Micropalama himantopus*)

Spring Arrival: 23 May - SR

Spring Departure: 2 June - SR

Fall Arrival: 14 July - SR

Fall Departure: 8 September - SR

Status: Migrant

The Stilt Sandpiper migrates through the study area on its way to and from arctic breeding grounds.

Buff-breasted Sandpiper (*Tryngites subruficollis*)

Spring Arrival: U

Spring Departure: U

Fall Arrival: 3 August - SR

Fall Departure: 12 September - SR

Status: Migrant

The Buff-breasted Sandpiper, which breeds in the arctic, has only been observed in the study area during fall migration.

7.1.3.11 Jaegers, Gulls and Terns. Surveys of breeding colonies of gulls and terns have been minimal, however indications are that breeding populations are small and that most of the colonies are outside the surface-mineable area. Thus the main impact of tar-sands development will be increased human activity, which may effect the breeding colonies. Non-breeding birds within the study area will probably benefit from industrial development as the number and size of refuse dumps will increase. The effects of toxic chemicals still need to be studied.

Parasitic Jaeger (*Stercorarius parasiticus*)

Status: Wanderer

The Parasitic Jaeger, which breeds on the arctic coasts, usually follows the Pacific and Atlantic coasts to wintering grounds, but may occasionally migrate inland (Salt and Salt 1976). The Parasitic Jaeger has been recorded in the Fort Chipewyan area on several occasions (Salt and Salt 1976). Two individuals were observed on 1 September 1975 as they flew over Ruth Lake (Sharp and Richardson 1976).

Long-tailed Jaeger (*Stercorarius longicaudus*)

Status: Wanderer

On 13 June 1933 a single Long-tailed Jaeger was observed near the head of Rivière des Rochers (Soper 1942).

Glaucous Gull (*Larus huperboreus*)

Spring Arrival: U

Spring Departure: U

Fall Arrival: 24 July 1975 - W

Fall Departure: 2 September 1975 - W

Status: Wanderer

This species was recorded on Lease 17 during the above period and up to 8 individuals at one time were sighted (Ward et al. 1976). The normal migration route of this species is a coastal one and its occurrence in the interior is scarce (Godfrey 1966).

Herring Gull (*Larus argentatus*)

Spring Arrival: 29 April

Fall Departure: 20 October - SR

Status: Breeds - G

The breeding range of the Herring Gull is described as including the study area (Godfrey 1966). Herring Gulls usually nest on the ground on an island or rock in the water (Salt and Salt 1976). At the Syncrude site, non-breeding Herring Gulls were the second most common gull species present during 1975 (Sharp and Richardson 1976).

Thayer's Gull (*Larus thayeri*)

Status: Wanderer

The Thayer's Gull, which breeds on the arctic coasts, is a rare species in Alberta (Salt and Salt 1976). A few adults of this species were observed at the Syncrude refuse dump during late September and early October (Sharp and Richardson 1976).

California Gull (*Larus californicus*)

Spring Arrival: 28 April

Fall Departure: 20 October - SR

Status: Breeds

The California Gull breeds locally throughout the study area on islands (Salt and Salt 1976). Breeding colonies of this species have been reported on Namur and Birch Lakes (R. Beaver pers.

comm. 1977) The California Gull was the most common non-breeding gull observed on the Syncrude site during 1975 (Sharp and Richardson 1976).

Ring-billed Gull (*Larus delawarensis*)

Spring Arrival: 28 April
Fall Departure: 29 September
Status: Breeds

The breeding range of the Ring-billed Gull has been described as including the study area (Salt and Salt 1976). Although this gull was the third most abundant non-breeding gull on the Syncrude site, 94% of the total birds observed were seen after 11 August (Sharp and Richardson 1976). A suspected colony of Ring-billed Gulls was reported at Namur Lake (Beaver 1977).

Mew Gull (*Larus canus*)

Spring Arrival: U
Spring Departure: U
Fall Arrival: 3 August - SR
Fall Departure: 20 October - SR
Status: Migrant

The Mew Gull migrates along the Pacific coast, spreading eastward to nest, and has been recorded nesting as close to the study area as the Saskatchewan side of Lake Athabasca (Salt and Salt 1976). Mew Gulls observed in northern Alberta during the summer are largely non-breeding sub-adults (Salt and Salt 1976). During 1975 surveys of the Syncrude site, 252 Mew Gulls were observed during fall migration while none was reported during spring migration (Sharp and Richardson 1976).

Franklin's Gull (*Larus pipixcan*)

Spring Arrival: 28 April
Fall Departure: 23 August - SR
Status: Breeds

Two breeding colonies of Franklin's Gulls, consisting of 135 to 140 pairs, were observed in the Peace-Athabasca Delta (Beaver 1977).

Bonaparte's Gull (*Larus philadelphia*)

Spring Arrival: 4 May

Fall Departure: late September

Status: Breeds

Lakes which are surrounded by coniferous muskegs are the favoured breeding habitat of the Bonaparte's Gull. Black spruce 8 to 12 m tall seem to be the preferred nesting site.

Sabine's Gull (*Xema sabini*)

Status: Wanderer

One individual was observed at the mouth of the Firebag River on 27 August 1976. Other observations have been reported on the Athabasca River (Salt and Salt 1976).

Common Tern (*Sterna hirundo*)

Spring Arrival: 6 May - SR

Fall Departure: late September

Status: Breeds

The Common Tern breeds throughout the study area, however this species appears to be more common in the shield area north of our study area. Common Terns are typically colonial and nest on islands (Salt and Salt 1976).

Arctic Tern (*Sterna paradisaea*)

Spring Arrival: U

Fall Departure: U

Status: Breeds?

There were two possible Arctic Tern sightings made at McClelland Lake during 1976. During surveys conducted in 1975, a colony of 12 individuals (suspected of breeding) was located in an area southeast of Richardson Lake (Bishoff and Fyfe 1976).

Caspian Tern (*Sterna caspia*)

Spring Arrival: 1 June

Fall Departure: U

Status: Breeds - B

Breeding populations of Caspian Terns are restricted to the Peace-Athabasca Delta and Lake Athabasca. A colony of 40 to 60 pairs nested on Egg Island in Lake Athabasca. There are unsubstantiated reports of a few pairs nesting on an island in Frezie Lake.

Black Tern (*Childonias niger*)

Spring Arrival: mid-May

Fall Departure: early September

Status: Breeds

The Black Tern, which builds its floating nest in emergent vegetation, is usually found around shallow lakes and marshes. It breeds throughout the area but does not appear to be very abundant.

Rock Dove (*Columba livia*)

Status: Wanderer (Resident?)

The Rock Dove may be resident in Fort McMurray and Fort Chipewyan.

Mourning Dove (*Zenaida macroura*)

Status: Wanderer

Several individuals were observed in the vicinity of Mildred Lake and one individual was recorded near McClelland Lake.

7.1.3.12 Owls. Eight species of owls have been recorded in the study and, of these, seven have bred (five year-round residents, two summer residents). The effects of habitat destruction should be minimal, however the effects of chemical contamination should be the focus of future studies.

Great Horned Owl (*Bubo virginianus*)

Status: Resident

The Great Horned Owl is the commonest owl species in the area and is most often associated with mixed forests. The Great Horned Owl is an early nester.

Mature balsam poplar/scrub willow plot 2 territories/100 ha

Snowy Owl (*Nyctea scandiaca*)

Spring Departure: U

Fall Arrival: 23 October

Status: Winter Resident

Some Snowy Owls migrate south from their breeding grounds to spend the winter in the southern parts of Canada. The majority of birds pass through the study area and spend the winter on the prairies, as they prefers open habitats. The Snowy Owl has been observed on the cleared areas of the Syncrude Lease, and areas such as this would be attractive to this species during migration. The Syncrude Lease has also proved attractive as a year-round area. A single Snowy Owl was resident on the lease throughout the summer of 1977 (Keith Yonge, pers. comm. 1977).

Hawk Owl (*Surnia ulula*)

Status: Resident

The Hawk Owl, although present throughout the area, is a rare species and has only been observed on a few occasions during the last two years. The Hawk Owl has been associated with muskeg habitats, especially open ones with tall dead spars or living trees.

Barred Owl (*Strix varia*)

Status: Resident

The Barred Owl has only been recorded on two occasions, and in both instances the birds were associated with river valleys.

Great Gray Owl (*Strix nebulosa*)

Status: Resident

The Great Gray Owl is found throughout the area but is a uncommon. It has been observed in mixed forests and also in muskegs.

Long-eared Owl (*Asio otus*)

Spring Arrival: U

Fall Departure: U

Status: Breeds - G

A dead Long-eared Owl found near Fort MacKay on 23 August 1977 is our only record for the area. Two observations of this species were made on the Syncrude Lease (Sharp and Richardson 1976).

Short-eared Owl (*Asio flammeus*)

Spring Arrival: 28 April - SR

Fall Departure: 10 October - SR

Status: Breeds

The Short-eared Owl is found throughout the area but its abundance is not clearly understood. It is found in and around the more open habitats such as marshes, lakes and muskegs.

Boreal Owl (*Aegolius funereus*)

Status: Resident

The Boreal Owl is a rare species in the study area and has been observed in tall, mature, mixed forests.

Common Nighthawk (*Chordeiles minor*)

Spring Arrival: 24 May

Fall Departure: early September

Status: Breeds

The Common Nighthawk is found throughout the study area. It breeds in a variety of habitats but prefers open mature jack pine stands that have an open, lichen-covered forest floor. Night Hawks will also nest in open cutlines and clearings. During migration large flocks may congregate along cutlines, clearings and rivers.

Open mature jack pine subplot	5 territories/100 ha

Ruby-throated Hummingbird (*Archilochus colubris*)

Status: Wanderer

There were two observations of hummingbirds in the area and they probably were of this species.

Belted Kingfisher (*Megaceryle alcyon*)

Spring Arrival: 4 May

Fall Departure: 25 September

Status: Breeds

The Belted Kingfisher has been recorded throughout the study area along a variety of lakes and rivers. This species nests in cavities excavated in banks, and is most commonly found along streams which support good fish populations.

7.1.3.13 Woodpeckers.

Common Flicker (*Colaptes auratus*)

Spring Arrival: 20 April

Fall Departure: 3 October

Status: Breeds

The Common Flicker breeds throughout the study area in a variety of forest types. Typically, mature, mixed forests are the preferred breeding habitat. Large dead or dying trees are the usual nesting sites of the Common Flicker (Salt and Salt 1976). The Common Flicker forages for insects on both standing and fallen trees as well as foraging for insects on the ground.

Bitumount muskeg (1976)	3	territories/100 ha
Bitumount muskeg (1977)	3	"
Tall bottomland willow	2	"
Aspen-pine plot	3	"
Hartley Creek plot	3	"
LaFont Island	4	"
Mature black spruce	5	"
Open bog plot	3	"
Mature balsam popular/scrub willow plot	4	"
River valley mixed forest	8	"
Mature mixed forest	7	"
Young mixed forest	2	"
Young black spruce	2	"

Pileated Woodpecker (*Dryocopus pileatus*)

Status: Resident

This uncommon woodpecker is found throughout the area and prefers areas of mature, mixed forests. In this type of forest densities of two territories per 100 ha have been recorded during this study. The Pileated Woodpecker has also been observed in less mature stands of mixed forest. Foraging has been observed both in coniferous and deciduous trees but the latter seem to be preferred.

Yellow-bellied Sapsucker (*Sphyrapicus varius*)

Spring Arrival: 26 April

Fall Departure: 29 September

Status: Breeds

The Yellow-bellied Sapsucker is common throughout the area in a variety of habitats with mature, mixed forests being the preferred habitat. Nesting cavities, which have been located, were excavated in aspen trunks at least 15 cm in diameter. This species has been observed to forage in shrub-dominated habitats.

Aspen-pine forest plot	6	territories/100 ha
Mature mixed forest plot	24	"
River valley mixed forest	14	"
LaFont Island	4	"

Hairy Woodpecker (*Picoides villosus*)

Status: Resident

This year-round resident can be found in a variety of forest types but it is most often observed in mature, deciduous or deciduous-dominated forests.

Aspen-pine plot	2	territories/100 ha
Mature mixed forest plot	2	"
River valley mixed forest plot	3	"
Mature balsam poplar/scrub willow	6	"
Mature black spruce plot	6	"
Bitumount muskeg plot (1976)	3	"
Bitumount muskeg plot (1977)	3	"

Downy Woodpecker (*Picoides pubescens*)

Status: Resident

The Downy Woodpecker has most often been observed in deciduous-dominated forests. It did not occur as a breeding species on any of the study plots. The Downy Woodpecker is less common than the Hairy Woodpecker.

Black-backed Three-toed Woodpecker (*Picoides arcticus*)

Status: Resident

This uncommon woodpecker prefers mature coniferous forests with mature jack pine-dominated sites possibly being the preferred cover type. This woodpecker is usually seen foraging on the lower portions of coniferous trees and it has also been observed to utilize fallen trees. There have been no substantiated breeding territories on any of the plots. This species appears to be less common than the Northern Three-toed Woodpecker.

Northern Three-toed Woodpecker (*Picoides tridactylus*)

Status: Resident

The Northern Three-toed Woodpecker breeds in mature coniferous-dominated forests. Although our highest recorded density has been in a stand of mature black spruce, incidental observations of individuals and nest sites suggest that this species has a preference for mature jack pine-dominated sites. Two nesting cavities belonging to this species were located in mature jack pines. This species seems to prefer foraging in the lower portions of conifers.

Aspen-pine plot	1 territory/100 ha
Mature jack pine plot	2 "
Mature black spruce plot	6 "

7.1.3.14 Flycatchers.

Eastern Kingbird (*Tyrannus tyrannus*)

Spring Arrival: 21 May

Fall Departure: 15 September

Status: Breeds

Open muskegs, marshes, lakeshores and man-made clearings are the typical habitats where the Eastern Kingbird can be found breeding. Open habitats, which have an abundance of perch sites, are preferred as these habitats facilitate the Eastern Kingbird's feeding method of catching flying insects. During 1977, this species was found on the open bog plot and on the tamarack muskeg plot, both of which were characterized by scattered trees or abundance of dead snags. Dead emergent willows around the perimeters of lakes are also frequently utilized by this species. Placing dead snags throughout reclaimed areas will provide perching and nesting sites for the Eastern Kingbird.

Tamarack muskeg plot	7 territories/100 ha

Scissor-tailed Flycatcher (*Muscivora forficata*)

Status: Wanderer

The Scissor-tailed Flycatcher has been observed three times within Alberta, including once (17 June 1952) at Fort Chipewyan (Salt and Salt 1976)

Eastern Phoebe (*Sayornis phoebe*)

Spring Arrival: 20 April

Fall Departure: late August

Status: Breeds

Within the study area, the Eastern Pheobe is most often seen around man-made clearings and frequently utilizes buildings and other structures for its nest site (the full time presence of people may be limiting). Natural nesting sites would probably be located under overhangs on rock or sandstone outcrops along rivers and streams.

Say's Pheobe (*Sayornis saya*)

Status: Wanderer

From 7 to 9 May 1977, several Say's Pheobes were observed feeding around the Shell test pit. On 2 September 1975 one individual was observed on the Syncrude site (Sharp and Richardson 1976). There is no definite evidence of breeding by the Say's Phoebe in northern Alberta (Godfrey 1966). Barren prairie coulees, river banks, and cliffs of the badlands are favoured breeding areas (Salt and Salt 1976) and, consequently, mined areas may prove attractive to this species.

Yellow-bellied Flycatcher (*Empidonax flaviventris*)

Spring Arrival: late May

Fall Departure: 1 September - SR

Status: Breeds

The Yellow-bellied Flycatcher has been described as breeding in moss-floored habitats such as willow-alder thickets (with or without conifers), mixedwood forests, and muskegs (Godfrey 1966; Salt 1976). Subplot data suggest that a stand of pure black spruce, which is open above 2 m, can support densities of 27 territories per 100 ha and may be the preferred habitat. Within the study plots, breeding territories of the Yellow-bellied Flycatcher have been associated with coniferous portions of the habitats.

Young mixed forest plot	10 territories/100 ha
Interface plot	7 "
Young black spruce plot	8 "
Bitumount muskeg plot (1976)	7 "
Bitumount muskeg plot (1977)	3 "

Alder Flycatcher (*Empidonax alnorum*)

Spring Arrival: late May

Fall Departure: 25 September

Status: Breeds

Alder Flycatchers can be found breeding in willow muskegs and fens and in riparian willow and alder stands, however stands of willow appear to be preferred to stands of alder. Alder Flycatchers have bred in willow as short as 1.5 m; however, we have observed their densities to be much higher in taller stands. Their territories are invariably located in areas which do not have a tree canopy.

LaFont Island	10	territories/100 ha
Hartley Creek valley plot	19	"
Interface plot	9	"
Tall bottomland willow plot	12	"
Deciduous shrub fen plot	18	"
Open bog plot	3	"
Bitumount muskeg plot (1976)	15	"
Bitumount muskeg plot (1977)	14	"
Willow-dominated subplot--deciduous shrub fen plot	69	"

Least Flycatcher (*Empidonax minimus*)

Spring Arrival: 17 May
Fall Departure: early September
Status: Breeds

As most of its food is caught on the wing (Salt and Salt 1976), the Least Flycatcher prefers habitats which provide both suitable protective cover and sufficient "hawking-space". Deciduous forests and the deciduous portions of mixed forests, on dry to mesic sites, are the typical breeding habitat of this species within the study area. Deciduous foliage (open and of shrub and/or tree composition), somewhere between 2 to 15 m above the forest floor, is the limiting factor for the Least Flycatcher. Preferred breeding habitat seems to be those deciduous forests in which an open subcanopy is present between 3 and 8 m above ground. Willow appears to be the preferred species, whereas speckled alder is generally avoided. Ecotones or interfaces between deciduous forests and clearings or water are also favoured haunts of the Least Flycatcher; these situations provide excellent cover as well as "hawking-space". In shrub-dominated habitats, the addition of a tree canopy seems to be beneficial.

However, in tree-dominated habitats, the height and density of the deciduous tree canopy seems to be of little consequence as long as the requirements within the critical subcanopy zone are met.

Bitumount aspen forest plot	103	territories/100 ha
McClelland aspen forest plot	9	"
Mature mixed forest plot	6	"
River valley mixed forest transect	6	"
Mature balsam poplar/scrub willow	107	"
LaFont Island	32	"
Tall bottomland willow plot	4	"
Bitumount aspen subplot: willow subcanopy	180	"

Western Wood Pewee (*Contopus sordidulus*)

Spring Arrival: 20 May

Fall departure: late August

Status: Breeds

The Western Wood Pewee prefers coniferous-dominated forests, with open to dense tree canopies, as breeding habitat. This species utilizes all coniferous tree species, however spruce appears to be preferred. Suitable forests can be situated on sites varying from dry and sandy to water-saturated and moss-carpeted. Most observations of this species have been in forests which are 8 m or more in height, however they were present in substantial numbers in a stand of mature but stunted tamarack. Western Wood Pewees frequently call from the tops of tall trees.

Aspen-pine plot	7	territories/100 ha
Mature mixed forest plot	4	"
Mature black spruce plot	21	"
Bitumount muskeg plot (1976)	3	"
Tamarack muskeg plot	15	"

Olive-sided Flycatcher (*Nuttalornis borealis*)

Spring Arrival: 15 May

Fall Departure: 20 August - SR

Status: Breeds

The breeding range of the Olive-sided Flycatcher is described as including the entire study area (Godfrey 1966); however, within the study area it is a relatively uncommon breeder. Typical situations in which this species will be found breeding are mature, coniferous or mixed forests, which provide considerable height diversity or an open canopy, or interface situations where there are differences in height between the two habitats. Both nesting and singing locations are usually at a considerable height in a conifer. Spruce appears to be preferred to jack pine.

Aspen-pine plot	2 territories/100 ha
Mature black spruce plot	11 "

Horned Lark (*Eremophila alpestris*)

Spring Arrival: 12 May

Spring Departure: U

Fall Arrival: 30 August

Fall Departure: 3 October

Status: Migrant (Breeds?)

During migration this common migrant can be found along cutlines, airstrips, clearings or other open areas. This species, which requires dry, open areas, may nest in the Lake Athabasca area (Godfrey 1966). As strip-mined areas become available, the Horned Lark may start to utilize these areas as breeding habitat. A recently fledged juvenile Horned Lark, observed on the Syncrude site, suggests that this trend may already be in effect (Sharp and Richardson 1976).

7.1.3.15 Swallows. For the three commonly occurring species of Swallows in the study area (Tree Swallow, Barn Swallow, and Cliff Swallow), the development of the tar sands industry will have few adverse effects. These species readily adapt to the presence of man and use his buildings and other structures for nest sites.

The destruction of forested areas during mining operations has both positive and negative effects on Swallows. On the positive side, cleared areas provide excellent areas where these aerial-feeding species can forage. The negative side effect relates to the destruction of trees and the loss of nest sites, which are needed by the Tree Swallow. However, this loss is easily mitigated by erecting dead, hollow trees in reclaimed areas. The overall effect of tar sands development will be minimal, and in the long-run may even be beneficial, for the Swallow family.

Tree Swallow (*Iridoprocne bicolor*)

Spring Arrival: 26 April

Fall Departure: 25 August - SR

Status: Breeds

The Tree Swallow can be found to breed throughout the study area, wherever there are forests bordering a lake or river. The limiting factor for the Tree Swallow is the abundance of nest sites. The typical nesting site is a natural tree cavity or an abandoned woodpecker hole. The Tree Swallow prefers to forage over water or marshes and occasionally open muskegs. Tree Swallows adapt quite readily to the presence of man and will frequently nest in man-made structures.

Bank Swallow (*Riparia riparia*)

Spring Arrival: 10 May

Fall Departure: mid-August

Status: Breeds

The Bank Swallow nests in steep banks usually in the vicinity of a river or lake. This species nests throughout the study area (Godfrey 1966), however it is only locally abundant. Several pairs attempted to nest in a river bank along the river transect but the nest sites were subsequently destroyed by high water levels. During 1977 a pair was present at the Shell test pit where they may have been nesting in the face of the excavation pit. Bank Swallows bred on the Syncrude site (Sharp and Richardson 1976).

Rough-winged Swallow (*Stelgidopteryx ruficollis*)

Spring Arrival: U

Fall Departure: U

Status: Breeds - W

One pair successfully nested in the area of Syncrude Lease 17 during 1975. The normal range of the Rough-winged Swallow is well south of the study area.

Barn Swallow (*Hirundo rustica*)

Spring Arrival: 2 May

Fall Departure: 15 September

Status: Breeds

The Barn Swallow is found throughout the area, usually in association with buildings and other structures where it can build a protected nest. This species has been observed to bring off two broods during one breeding season in the study area.

Cliff Swallow (*Petrochelidon pyrrhonota*)

Spring Arrival: 15 May

Fall Departure: early September

Status: Breeds

The Cliff Swallow breeds along rivers and streams where sandstone banks or bridges are present. Natural nest sites are located under sandstone overhangs. These birds are colonial by nature and may form colonies of many individuals. The colony nesting on the Fort MacKay bridge numbers approximately 70 birds.

Purple Martin (*Progne subis*)

Spring Arrival: U

Fall Departure: U

Status: Breeds - G

There are no recent records of this bird within the area but older records indicate that it has occurred as a breeder at Fort McMurray.

7.1.3.16 Corvids.

Gray Jay (*Perisoreus canadensis*)

Status: Resident

The Gray Jay is a common resident over the whole area and inhabits a variety of coniferous-dominated forests. This species is an early nester as a record of a nest containing four young on 11 April indicates. The Gray Jay bred on all but one of the coniferous-dominated plots.

Aspen-pine plot	3	territories/100 ha
Mature jack pine plot	4	"
Mature mixed forest plot	5	"
Young mixed forest Plot	12	"
River valley mixed forest	6	"
Hartley Creek valley plot	8	"
Interface plot	3	"
Tall bottomland willow plot	4	"
Open bog plot	8	"
Young black spruce plot	9	"
Mature black spruce plot	9	"
Bitumount muskeg (1976)	6	"
Bitumount muskeg (1977)	3	"
Tamarack plot	3	"

Blue Jay (*Cyanocitta cristata*)

Status: Resident

This species has been recorded as far north as McClelland Lake. It is known to be a year-round resident near Fort MacKay on the Athabasca River and is presumed to breed in the area. Most of the observations of the Blue Jay have been made in the more mature, mixed forests. Blue jays on the mature mixed forest plot had a breeding density of three territories per 100 ha.

Black-billed Magpie (*Pica pica*)

Status: Resident

This species is most common along the Athabasca River and its tributaries. Our observations suggest that this species prefers the willow-dominated areas along rivers and streams. It bred on the tall bottomland willow plot at a density of two territories per 100 ha.

Common Raven (*Corvus corax*)

Status: Resident

The Raven is found throughout the area and breeds in a variety of mature forests. Nests, which are constructed in early March, are usually placed in tall trees such as 25 m tall balsam poplar. The Raven is a scavenger and will frequent the garbage dumps of towns or camps.

Mature balsam poplar/scrub willow plot	2 territories/100 ha
LaFont Island	2 "

Common Crow (*Corvus brachyrhynchos*)

Spring Arrival: 3 May

Fall Departure: 13 October

Status: Breeds - G

The Common Crow is not abundant in the area and its exact breeding status is not known.

7.1.3.17 Chickadees and Nuthatches. Chickadees and Nuthatches commonly excavate nesting cavities in decaying stumps and trees and are also known to utilize abondoned woodpecker holes. Consequently, nesting sites may be the limiting factor in any given habitat.

Black-capped Chickadee (*Parus atricapillus*)

Status: Resident

The Black-capped Chickadee is most often observed in deciduous or mixed forests where it forages on tree surfaces for insect life. The Black-capped Chickadee is a cavity nester, which will delay colonization of reclaimed sites. Placing standing dead trees in reclaimed areas may help.

Bitumount aspen plot	5 territories/100 ha
McClelland aspen plot	2 "
Aspen-pine plot	2 "
Mature mixed forest plot	2 "
River valley mixed forest plot	5 "
Mature balsam poplar/scrub willow	4 "
Interface plot	3 "
Tall bottomland willow plot	4 "
Bitumount muskeg (1976)	1 "
Bitumount muskeg (1977)	5 "

Boreal Chickadee (*Parus hudsonicus*)

Status: Resident

The Boreal Chickadee is commonly found in coniferous-dominated forests throughout the area where it forages on tree surfaces for insect life. The Boreal Chickadee is a tree cavity nester.

Aspen-pine plot	2 territories/100 ha
Mature jack pine plot	4 "
Mature mixed forest plot	5 "
Young mixed forest plot	2 "
Young black spruce plot	9 "
Mature black spruce plot	9 "
Bitumount muskeg plot (1976)	3 "
Bitumount muskeg plot (1977)	8 "

Red-breasted Nuthatch (*Sitta canadensis*)

Spring Arrival: 26 April - SR

Fall Departure: 14 September

Status: Breeds

The Red-breasted Nuthatch is found throughout the area in mature coniferous-dominated habitats. This is true both for the breeding period and migration. The Red-breasted Nuthatch forages almost entirely on coniferous trees.

Aspen-pine forest plot	8 territories/100 ha
Mature mixed forest plot	11 "
Interface plot	3 "

Brown Creeper (*Certhia familiaris*)

Status: Wanderer

Two Brown Creepers were observed on 9 September 1976 at McClelland Lake. The normal range of this species is south of the study area (Salt and Salt 1976).

7.1.3.18 Wrens.

House Wren (*Troglodytes aedon*)

Spring Arrival: U

Fall Departure: U

Status: Breeds - G

The House Wren is a very sporadic breeder in the area and has not been observed by project personnel. A pair was regularly observed at the Lower Syncrude Camp during 1975 (Sharp and Richardson 1976). The breeding range of the House Wren includes most of the study area (Godfrey 1966), however its occurrence is limited.

Winter Wren (*Troglodytes troglodytes*)

Spring Arrival: 18 May

Fall Departure: 7 September - SR

Status: Breeds

A scarce breeder in the study area, the Winter Wren was observed on only one of the study plots, the mature mixed forest plot, where it bred at a density of 11 territories per 100 ha. The breeding range of this species includes most of the study area (Godfrey 1966).

Long-billed Marsh Wren (*Telmatodytes palustris*)

Spring Arrival: U

Fall Departure: U

Status: Breeds

The Long-billed Marsh Wren nests in cattails or bulrush around the edge of a lake or marsh. This species is locally common and can be found throughout the area. They have been reported to breed at Birch Lake (Beaver pers. comm. 1977).

Short-billed Marsh Wren (*Cistothorus platensis*)

Status: Wanderer

A singing male was observed 26 May 1977 in a *Betula pumila*-*Carex* spp. fen near the Muskeg River. The normal range of the Short-billed Marsh Wren is well southeast of the study area (Godfrey 1966).

7.1.3.19 Thrushes.

American Robin (*Turdus migratorius*)

Spring Arrival: 15 April

Fall Departure: 14 October

Status: Breeds

The American Robin breeds throughout the study area in a variety of habitats. Dense, tall willow with a scattered canopy of aspen or balsam poplar appears to be the preferred habitat. Speckled alder, typically found on drier sites, does not appear to be suitable. Mesic sites are preferred by this species. During fall migration large flocks of Robins congregate along cutlines in almost all habitats.

Young jack pine plot	1	territories/100 ha
River valley mixed forest plot	7	"
Mature balsam poplar/scrub willow	9	"
LaFont Island	8	"
Tall bottomland willow plot	11	"
Deciduous shrub fen plot	2	"

Hermit Thrush (*Catharus guttatus*)

Spring Arrival: 22 April

Fall Departure: 3 October

Status: Breeds

The Hermit Thrush is found throughout the study area; mixed forests and pure coniferous or deciduous forests may all be used as breeding habitat. The Hermit Thrush is associated with the forest floor and lower stratum of the forest (Godfrey 1966). As these strata have varied considerably (from scattered ericaceous-shrubs and lichens with a scrub jack pine canopy to dense forbs and ericaceous shrubs with dense alder) in habitats utilized by this species, its requirements in these two strata are not clearly defined. The tree canopy seems to have little effect on the Hermit Thrush.

Bitumount aspen plot	14	territories/100 ha
McClelland aspen plot	7	"
Aspen-pine plot	10	"
Young jack pine plot	9	"
Young mixed forest plot	10	"
River valley mixed forest plot	3	"
Hartley Creek valley plot	2	"
Interface plot	9	"
Young black spruce plot	1	"
Bitumount muskeg plot (1976)	5	"

Swainson's Thrush (*Catharus ustulatus*)

Spring Arrival: 27 April - SR

Fall Departure: 27 September - SR

Status: Breeds

The Swainson's Thrush breeds in a wide variety of habitats throughout the study area. Suitable habitat can range from young jack pine on a dry, sandy site to mature black spruce growing on a water-saturated muskeg. However, preferred habitats have several specific characteristics. Swainson's Thrush prefers habitats which are located on mesic to wet sites and which are greater than 5 m in height. The presence of deciduous or mixed foliage which creates a continuous layer of foliage from 2 to 6 m is essential. Speckled alder when dominant appears to be unsuitable. We can not state with any certainty a preference for deciduous over mixed foliage, however the nesting site has been described as low in an evergreen (Godfrey 1966) and this suggests a preference for the latter. The type of tree canopy does not appear to limit the Swainson's Thrush, however open canopies appear to be preferred to dense canopies.

Bitumount aspen plot	24	territories/100 ha
Aspen-pine plot	6	"
Young jack pine plot	7	"
Mature mixed forest plot	52	"
Young mixed forest plot	10	"
River valley mixed forest plot	27	"
Mature balsam poplar/scrub willow plot	38	"
LaFont Island	22	"
Hartley Creek valley plot	30	"
Interface plot	17	"
Tall bottomland willow plot	38	"
Young black spruce plot	19	"
Mature black spruce plot	9	"
Bitumount muskeg plot (1976)	19	"
Bitumount muskeg plot (1977)	8	"

Gray-cheeked Thrush (*Catharus minimus*)

Spring Arrival: U

Spring Departure: U

Fall Arrival: U

Fall Departure: U

Status: Migrant

The Gray-cheeked Thrush, which breeds north of Alberta (Salt and Salt 1976), is an uncommon migrant through the study area.

Veery (*Catharus fuscescens*)

Status: Wanderer

Two males were heard singing near the confluence of the Muskeg River and Hartley Creek on 27 May 1977. The normal breeding range of the Veery is south of the study area (Salt and Salt 1976).

Mountain Bluebird (*Sialia carrucoides*)

Spring Arrival: U

Fall Departure: U

Status: Breeds - C

There has been one observation of two females in an open tamarack bog on 29 September 1977. This species breeds in open areas and, although it has been reported to breed in the Fort McMurray area (Godfrey 1966), its occurrence must be very sporadic.

7.1.3.20 Kinglets.

Golden-crowned Kinglet (*Regulus satrapa*)

Spring Arrival: 13 May

Fall Departure: 25 September

Status: Breeds - S

The Golden-crowned Kinglet, which is reported to breed in the Fort Chipewyan and Wood Buffalo National Park areas (Salt and Salt 1976), has only been recorded as a migrant during the course of this study.

Ruby-crowned Kinglet (*Regulus calendula*)

Spring Arrival: 20 April

Fall Departure: 30 September - SR

Status: Breeds

The Ruby-crowned Kinglet breeds throughout the study area in a variety of spruce-dominated forests. Within the study area black spruce muskegs appear to be the preferred habitat. Jack pine-dominated forests are unsuitable as breeding habitat. The decline of 1977 densities on the Bitumount muskeg plot probably reflects a high winter-kill suffered by this species during the winter of 1976-77 (Gee 1977). Elsewhere in Canada the Ruby-crowned Kinglet breeds in white spruce forests and, since the reclamation of black spruce muskegs is unlikely, the planting of white spruce may mitigate the loss of black spruce muskegs for this species.

Mature mixed forest plot	3	territories/100 ha
River valley mixed forest plot	2	"
Hartley Creek valley plot	3	"
Young black spruce plot	10	"
Mature black spruce plot	17	"
Bitumount muskeg plot (1976)	22	"
Bitumount muskeg plot (1977)	7	"

7.1.3.21 Pipits.

Water Pipit (*Anthus spinoletta*)

Spring Arrival: 10 May

Spring Departure: early June

Fall Arrival: 27 August - SR

Fall Departure: 3 October

Status: Migrant

The Water Pipit which nests north of Alberta is a common migrant through the area and makes rest stops in areas of low or sparse vegetation. This species is commonly observed along the Athabasca River where it makes rest stops along the shores.

Sprague's Pipit (*Anthus spragueii*)

Spring Arrival: U

Fall Departure: U

Status: Breeds?

Two singing males were heard at the Fort McMurray airport. The Sprague's Pipit is a bird of grasslands and fields and, as clearing for oil sands operations continues, this species may become more common as it may colonize these open areas.

7.1.3.22 Waxwings.

Bohemian Waxwing (*Bombycilla garrulus*)

Spring Arrival: 26 April - SR

Fall Departure: 24 October - SR

Status: Breeds - G

The exact status of this species is uncertain. Although the species is reported to breed within the area (Godfrey 1966), there have been very few summer observations; as such the Bohemian Waxwing must be considered to be an uncommon breeder. The Bohemian Waxwing winters in central Alberta (Godfrey 1966).

Cedar Waxwing (*Bombycilla cedrorum*)

Spring Arrival: 1 June - SR

Fall Departure: 1 September - W

Status: Breeds - G

Wandering flocks of Cedar Waxwings have been observed during the summer, however breeding birds have not.

Northern Shrike (*Lanius excubitor*)

Status: Resident

The Northern Shrike which has been reported to breed in the Lake Athabasca area (Godfrey 1966) is probably a year-round resident in that area. Over the rest of the study area the Northern Shrike has only been recorded as a rare winter resident and fall migrant. The main wintering range of the Northern Shrike (Salt and Salt 1976) is the prairies.

7.1.3.23 Starlings.

Common Starling (*Sturnus vulgaris*)

Spring Arrival: 26 April

Fall Departure: U

Status: Breeds (Resident?)

The Common Starling may be a year-round resident in Fort McMurray. There is, however, a definite migration of Starlings through the study area. Small flocks of starlings have been observed migrating north along the Athabasca River, presumably to Fort Chipewyan where they have been reported breeding (Salt and Salt 1976).

7.1.3.24 Vireos.

Solitary Vireo (*Vireo solitarius*)

Spring Arrival: 25 May

Fall Departure: early September

Status: Breeds

The Solitary Vireo is found in coniferous and mixed forests. Its preferred habitats are: stands where the tree canopy is open or made up of trees of varying heights; the edges of small woodland clearings; and interfaces between stands of different heights. Solitary Vireos defend rather large territories; their maximum densities in preferred habitat are probably not in excess of 20 territories per 100 ha.

Aspen-pine plot	6	territories/100 ha
Young jack pine plot	4	"
Mature mixed forest plot	5	"
Young mixed forest plot	5	"
Interface plot	13	"
Young black spruce plot	3	"
Bitumount muskeg plot (1977)	3	"

Red-eyed Vireo (*Vireo olivaceus*)

Spring Arrival: 21 May

Fall Departure: mid-September

Status: Breeds

The Red-eyed Vireo breeds in deciduous and mixed forests throughout the area. Aspen or balsam poplar forests with openings in the canopy are preferred, although deciduous-dominated mixed forests can also support high populations. The Red-eyed Vireo usually sings in the tops of deciduous trees.

Bitumount aspen plot	47	territories/100 ha
McClelland aspen plot	15	"
Aspen-pine plot	8	"
Mature mixed forest plot	17	"
Young mixed forest plot	2	"
River valley mixed forest plot	49	"
Mature balsam poplar/scrub willow	56	"
LaFont Island	12	"
Interface plot	9	"
Tall bottomland willow plot	6	"
Bitumount muskeg plot (1977)	3	"

Philadelphia Vireo (*Vireo philadelphicus*)

Spring Arrival: 18 May
Fall Departure: late August
Status: Breeds

The Philadelphia Vireo's preferred habitats are willow or alder uplands and the ecotone between deciduous forests and willow uplands. Tall shrubs or deciduous foliage which were over 5 m in height and forming a dense canopy or subcanopy were abundant on the plots which supported the highest densities of this species.

Bitumount aspen plot	3	territories/100 ha
McClelland aspen plot	2	"
LaFont Island	20	"
Hartley Creek valley plot	16	"
Tall bottomland willow plot	15	"
LaFont Island balsam poplar subplot	34	"

Warbling Vireo (*Vireo gilvus*)

Spring Arrival: 15 May
Fall Departure: early September
Status: Breeds

The Warbling Vireo breeds in open, deciduous or mixed forests which are dominated by tall (over 20 m) deciduous trees.

Mature mixed forest plot	3	territories/100 ha
Mature balsam poplar/scrub willow	6	"

7.1.3.25 Warblers.

Within the AOSERP study area, warblers form an important and interesting portion of the songbird population. The effects of the tar sands industry and their duration are hard to gauge for this group. Initially, clearing operations have a total and long-term impact on the species which regularly nested in the affected area. Present indications suggest that the reclamation of native habitats will be very difficult if not impossible and the type of "artificial habitats" which will be reclaimed have not been fully worked out. Consequently, it is hard to predict the number and density of warbler species which will utilize these reclaimed areas. However, it is our opinion that on a regional basis the change in warbler populations will be minimal.

Black-and-white Warbler (*Mniotilta varia*)

Spring Arrival: 7 May
Fall Departure: early September
Status: Breeds

The Black-and-white Warbler has been present in all the deciduous forests studied thus far and all but one of the mixed forests. It is found most commonly in areas of dense tall shrubs, with or without a tree canopy, or along the ecotone between a deciduous or mixed forest and a willow muskeg. Deciduous shrubs, especially willow, which range from 3 to 7 m in height, seem to be preferred over shorter shrubs. The poor drainage of a site and/or the proximity of water increase the value of the habitat to Black-and-white Warblers. This preference for the wetter areas of a forest or for muskegs has been noted by other researchers in northeastern Alberta (Randall 1933; Farley 1922). The tall bottomland willow plot, with its numerous oxbows and marshy places and with the Muskeg River meandering through the 3 to 8 m tall willow, represents ideal habitat for this species. Habitat of this type will be easier to reclaim than muskeg habitats. Because the Black-and-white Warbler maintains relatively large territories (frequently 2 ha or more), maximum densities in prime habitat would be approximately 40 territories per 100 ha.

Bitumount aspen forest plot	9	territories/100 ha
McClelland aspen forest plot	2	"
Mature mixed forest plot	6	"
Young mixed forest plot	20	"
River valley mixed forest plot	24	"
Mature balsam poplar/scrub willow	7	"
LaFont Island	10	"
Hartley Creek valley plot	33	"
Interface plot	12	"

Tall bottomland willow plot	28 territories/100 ha
Young black spruce plot	4 "
Bitumount muskeg plot (1976)	14 "
Bitumount muskeg plot (1977)	9 "

Tennessee Warbler (*Vermivora peregrina*)

Spring Arrival: 13 May

Fall Departure: 17 September

Status: Breeds

Probably the most abundant breeding bird in the study area, the Tennessee Warbler can be found in any habitat which provides even a small amount of deciduous foliage above 2 m. Suitability of habitat is less a function of the presence of foliage in a particular height range than of the horizontal patterning of foliage (Tennessee Warblers have been observed to sing and feed in low shrubs and the tops of tall trees). The presence in a horizontal plane at any height level, of dense deciduous or mixed foliage and openings at least 2 m wide determines the suitability of habitat. Preferred habitats are those which provide this foliage/space pattern at a variety of height levels: e.g., open forests, forests with tall, open understories, and interfaces between tall and short habitats. The Tennessee Warbler prefers spruce to pine, and may prefer willow to alder. Both dry and wet sites are utilized, although very dry habitats and those in which the water table is above ground level are less suitable.

Bitumount aspen forest plot	53 territories/100 ha
McClelland aspen forest plot	47 "
Aspen-pine forest plot	31 "
Mature mixed forest plot	103 "
Young mixed forest plot	27 "
River valley mixed forest	45 "
Mature balsam poplar/scrub willow	18 "
LaFont Island	60 "
Hartley Creek valley plot	75 "

Interface plot	76 territories/100 ha
Tall bottomland willow plot	49 "
Young black spruce plot	8 "
Bitumount muskeg (1976)	84 "
Bitumount muskeg (1977)	50 "

Orange-crowned Warbler (*Vermivora celata*)

Spring Arrival: 10 May

Fall Departure: 18 September

Status: Breeds

The Orange-crowned Warbler has been observed breeding, at relatively low densities, in a variety of mixed forest and mixed scrub situations. Our observations suggest a preference for dense thickets of tall shrubs under an open coniferous or mixed tree canopy. This preference for tall shrubs has been reported elsewhere (Salt 1973). We have also observed that tall shrubs, whether along a stream or river, on a muskeg or on a dry sandy site, can all provide suitable breeding habitat. Shrubs should be at least 2.5 m tall; however, we do not know if there is a maximum height limitation. It also appears that the tree canopy has a minimal effect on the Orange-crowned Warbler.

Aspen-pine forest plot	9 territories/100 ha
Mature mixed forest plot	1 "
Bitumount muskeg plot (1976)	15 "
Bitumount muskeg plot (1977)	3 "

Yellow Warbler (*Dendroica petechia*)

Spring Arrival: 13 May

Fall Departure: late August

Status: Breeds

The Yellow Warbler has been observed to breed only in deciduous habitats along rivers, streams, lakes or other water bodies. Along these waterways, dense thickets of willow and alder provide suitable breeding habitat. The presence of a deciduous tree canopy does not act as a deterrent, but it does reduce the desirability of the habitat if the tree canopy is dense or closed. We have recorded the Yellow Warbler in greatest abundance in extensive stands of scrub willow along the Athabasca River. On prairie slopes the Yellow Warbler also utilizes thickets of deciduous shrubs (Salt 1973). This would suggest that this species may utilize strip-mined areas which are reclaimed with shrubs.

River valley mixed forest plot	5 territories/100 ha (7 territories/km)
Mature balsam poplar/scrub willow	53 " (3.7 territories/km)
LaFont Island	22 "
Tall bottomland willow plot	5 "
Deciduous shrub fen plot	2 "
Sedge fen plot	26 " (1.5 territories/km)

Magnolia Warbler (*Dendroica magnolia*)

Spring Arrival: 20 May

Fall Departure: 18 September

Status: Breeds

Magnolia Warblers have been observed to breed in mixed forest stands. Our limited number of observations suggest a preference for dense copses of spruce, either mature and bordering an area of tall deciduous shrubs, or short and surrounded by an area of taller mixed forest. The presence of a deciduous-coniferous interface of a clearing appears to be important. Observations of singing males have revealed that they frequent both the coniferous and deciduous habitats along the interface. Salt (1973) describes their breeding habitat as the borders and clearings of coniferous and mixed-forests rather than their depths. The Magnolia Warbler occurs in small numbers within the study area.

Mature mixed forest plot	6 territories/100 ha
Young mixed forest plot	3 "
River valley mixed forest plot	14 "
Hartley Creek valley plot	19 "
Interface plot	1 "

Cape May Warbler (*Dendroica tigrina*)

Spring Arrival: 21 May

Fall Departure: late August

Status: Breeds

Observations of the Cape May Warbler in the study area have been limited and therefore a precise delineation of its habitat requirements is not possible. Singing males have been observed in mature mixed forests dominated by tall white spruce. Salt (1973) states that the presence of taller spruce whose spires rise well above the surrounding forest is essential to this species. Our observations fit this pattern.

Yellow-rumped Warbler (*Dendroica coronata*)

Spring Arrival: 21 April

Fall Departure: 25 October

Status: Breeds

The Yellow-rumped (Myrtle) Warbler seems to be ubiquitous in coniferous and mixed habitats over 3 m. Our data suggest that spruce and jack pine are equally suitable as breeding habitat. The highest densities we encountered were in a young mixed forest with a dense black spruce-dominated understory. Our data suggest that the Yellow-rumped Warbler prefers tall, dense stands to more open ones. In scrub forests and shorter forests, Yellow-rumped Warblers are frequently seen singing from dead spars or scattered, taller, live trees. These tall singing posts have been present in all of the shorter coniferous and mixed forests we have studied; their absence might have a limiting effect on the Yellow-rumped Warbler populations in these habitats. Salt (1973) states that the Yellow-rumped Warbler shows a decided preference for situations close to water, either stagnant or running. While we have found the Yellow-rumped Warbler in such habitats, it has been most commonly found in habitats which do not have any standing water. The recolonization of strip-mined areas by this species will be possible if coniferous tree species are planted and may be enhanced if standing dead spars are placed throughout the reclaimed area.

Aspen-pine forest plot	13	territories/100 ha
Mature jack pine plot	24	"
Young jack pine plot	30	"
Mature mixed forest plot	25	"
Young mixed forest plot	38	"
River valley mixed forest plot	8	"
Hartley Creek valley plot	6	"
Interface plot	10	"
Young black spruce plot	17	"
Mature black spruce plot	32	"
Bitumount muskeg plot (1976)	16	"
Bitumount muskeg plot (1977)	22	"
Tamarack muskeg plot	5	"
Young mixed forest-subplot 3	74	"

Black-throated Green Warbler (*Dendroica virens*)

Spring Arrival: 21 May
Fall Departure: 24 August
Status: Breeds

Black-throated Green Warblers are rare breeders in the study area; as such their habitat preferences in this area are obscure. Two territories were recorded in a mature riparian balsam/poplar-dominated mixed forest. White spruce, 19 m or taller, was scattered throughout this forest. This represents a substantial departure from its normal habitat which is described in the literature as extensive stands of mature coniferous trees or mixed-wood forests dominated by conifers (Salt 1973). Black-throated Green Warblers are a distinctive species of the fir forest (Erskine 1977) and consequently the sparsity of fir in the AOSERP area may limit the abundance of the Black-throated Green Warbler.

Chestnut-sider Warbler (*Dendroica pennsylvanica*)

Status: Wanderer - W

The Chestnut-sided Warbler was observed in the Mildred Lake area during 1974 and 1975 (Sharp et al. 1975; Sharp and Richardson 1976). Breeding records of the Chestnut-sided Warbler in Alberta have been confined to the east-central region of the province (Salt and Salt 1976).

Bay-breasted Warbler (*Dendroica castanea*)

Spring Arrival: 28 May

Fall Departure: late August

Status: Breeds

The Bay-breasted Warbler has been observed to breed in mixed-forest habitats which are dominated by coniferous trees. Our data suggest that a very mature, open, spruce-dominated mixed forest is preferred habitat and can support densities of approximately 30 territories per 100 ha. Incidental observations of singing males have also been made in mature stands of pure black spruce.

Mature mixed forest plot	19	territories/100 ha
Young mixed forest plot	4	"
River valley mixed forest plot	6	"

Blackpoll Warbler (*Dendroica striata*)

Spring Arrival: 20 May

Fall Departure: early September

Status: Breeds

During the breeding season, the Blackpoll Warbler has been observed in a variety of habitats, but substantiated territories have only been recorded on three plots. The territories on the young black spruce plot were located in an area dominated by black spruce less than 5 m tall, in which 2 to 3 m tall willow formed 10% of the understory stratum. The territories on the two deciduous shrub-dominated plots were situated in areas of dense, 3 to 6 m tall willow. Typical breeding habitat has been described as coniferous forests or mixed-wood forests which have fairly heavy stands of spruce (Salt 1973). Godfrey (1966) lists alder thickets as an alternate breeding habitat.

Palm Warbler (*Dendroica palmarum*)

Spring Arrival: 3 May

Fall Departure: 24 September

Status: Breeds

The Palm Warbler's preferred breeding habitat is black spruce muskeg in which black spruce anywhere from 2 to 8 m in height forms an open canopy. Also suitable, but less densely populated, are dense or closed young black spruce stands, of the same 2 to 8 m range, in which height diversity creates an open layer of spires above the denser foliage. Extensive stands of suitable habitat are not required; the Palm Warbler will breed in small copses of black spruce located in otherwise unsuitable habitat (e.g., the deciduous shrub fen plot). Palm Warblers also breed in small numbers in tamarack muskegs and fens, open black spruce 8 to 12 m tall and open canopied willow bogs in which some black spruce is present. Because the Palm Warbler is totally dependent on muskegs for breeding habitat and the reclamation of muskegs appears to be unlikely, the impact on this species of the mining operation within the surface-mineable area could be considerable.

Interface plot	8	territories/100 ha
Deciduous shrub/fen plot	6	"
Open bog plot	13	"
Young black spruce plot	68	"
Mature black spruce plot	11	"
Bitumount muskeg plot (1976)	48	"
Bitumount muskeg plot (1977)	47	"
Tamarack muskeg plot	5	"
Open young black spruce (4 to 8 m) subplot of the Bitumount Muskeg plot (1977)	179	"

Ovenbird (*Seiurus aurocapillus*)

Spring Arrival: 15 May

Fall Departure: early September

Status: Breeds

Ovenbirds were present in fair numbers in all the upland deciduous and mixed forests we sampled, but were absent from water-saturated habitats. In bottomland deciduous forests, Ovenbirds were limited to particularly well-drained sites. In upland mixed forests, Ovenbirds were confined to those areas moist enough to support a lush, herbaceous-dominated ground stratum. Thus, it appears likely that the suitability of deciduous or mixed habitats for Ovenbirds is determined by the adequacy of both the drainage and the herbaceous component of the ground stratum.

In Canada, the Ovenbird is generally thought to prefer closed-canopy deciduous forests with not too much understory and a good carpet of leaf litter (Godfrey 1966). Figure 23 is a photograph of an aspen forest which has the characteristics of "typical" Ovenbird habitat. The greatest densities of Ovenbirds we encountered, more than double those found on our other plots, were on the aspen forest portion of the Interface plot and on the Bitumount aspen forest plot. While the former fit exactly the standard criteria for Ovenbird habitat, the latter represented somewhat of an anomaly. The Bitumount aspen forest plot was characterized by a dense to closed tree canopy with a lush and almost equally dense shrub understory. Subplot analysis of this plot suggested (albeit by no means conclusively) a preference for a dense understory. It seems more likely that the understory densities are not a limiting factor and that stand height was the determining factor. Our plot data suggest that aspen stands in the 8 to 15 m range are preferred habitat.

Bitumount aspen forest plot	138	territories/100 ha
McClelland aspen forest plot	48	"
Aspen-pine forest plot	18	"
Mature mixed forest plot	31	"

Young mixed forest plot	32 territories/100 ha
River valley mixed forest plot	27 "
Mature balsam poplar/scrub willow	3 "
LaFont Island	12 "
Hartley Creek valley plot	8 "
Interface plot	45 "
Tall bottomland willow plot	9 "

Northern Waterthrush (*Seiurus noveboracensis*)

Spring Arrival: 13 May

Fall Departure: mid-September

Status: Breeds

The Northern Waterthrush is a strongly interface associated species; it breeds in deciduous or mixed uplands adjacent to standing or flowing water bodies. The preferred upland habitat is willow, taller than 4 m, with a grass or *Equisetum* ground cover, although a deciduous forest with a tall deciduous understory can also support substantial populations. Moss and forest floor litter are usually absent or scattered in preferred habitats. The soil and litter of the upland portion of a Waterthrush territory may be dry to damp while the soil and litter, if present, along the interface are usually wet. Streams, oxbows, and high water channels are preferred to lakes, as are larger rivers with tall unvegetated banks. Ponds situated in muskegs are not suitable for breeding habitat as the surrounding cover usually consists of black spruce or tamarack with thick carpets of moss on the forest floor.

River valley mixed forest	6 territories/100 ha (1.0 territories/km)
Mature balsam poplar/scrub willow	44 territories/100 ha (6.7 territories/km)
LaFont Island	44 territories/100 ha
Hartley Creek valley plot	31 territories/100 ha
Tall bottomland willow plot	62 territories/100 ha

Connecticut Warbler (*Oporornis agilis*)

Spring Arrival: 1 June

Fall Departure: mid-August

Status: Breeds

Our data suggest that the Connecticut Warbler is the last warbler species to arrive in the study area. Territorial males of this species have been recorded on two of our plots and in both cases the birds were associated with an aspen-jack pine forest with a dense, alder understory. Aspen-poplar woods or mixed forests, where deciduous trees are predominant, are the breeding habitats described in the literature (Salt 1973). The Connecticut Warbler does not appear to be an abundant species in the study area.

Mourning Warbler (*Oporornis philadelphia*)

Spring Arrival: 23 May

Fall Departure: 18 September

Status: Breeds

The Mourning Warbler has been observed to breed in dense willow or alder, especially when these shrubs occur along an edge situation such as a clearing within a forest, along streams and rivers or island edges. Shrubs less than 3 m in height seem to be preferred over taller shrubs. Typically these zones of shrubs are adjacent to taller trees and Mourning Warblers have been observed to utilize both of these components of the habitat. The breeding habitat of the Mourning Warbler is typically associated with mesic to well-drained sites.

Mature mixed forest plot	3	territories/100 ha
River valley mixed forest plot	18	"
Mature balsam poplar/scrub willow	20	"
LaFont Island	44	"
Hartley Creek valley plot	20	"

Common Yellowthroat (*Geothlypis trichas*)

Spring Arrival: 23 May

Fall Departure: late August

Status: Breeds

The Common Yellowthroat has been observed to breed in the deciduous shrubs around lakes and marshes and on water-saturated willow fens and muskegs (however densities in willow muskegs are lower). Willow, preferably between 1.5 and 3 m in height, is the preferred shrub species. The ground stratum in Yellowthroat habitat is usually dominated by sedges. The Yellowthroat will also breed in cattails and rushes which border the edges of lakes and marshes (Godfrey 1966).

Sedge fen plot	5	territories/100 ha
Bitumount muskeg (1976)	7	"
Bitumount muskeg (1977)	8	"
Deciduous shrub fen plot:		
Willow dominated subplot	99	"
Swamp birch dominated subplot	72	"

Wilson's Warbler (*Wilsonia pusilla*)

Spring Arrival: 20 May

Fall Departure: early September

Status: Breeds

Within the study area, the preferred breeding habitat of the Wilson's Warbler is not clearly understood. Willow bogs and some non-water-saturated willow habitats were utilized, although the highest breeding densities occurred in willow fens. The Wilson's Warbler usually locates its nest in a dry moss hummock (Salt 1973). Wilson's Warbler was absent from some very water-saturated willow fens (i.e., portions of the sedge fen plot). The absence of moss hummocks in these habitats may explain this phenomenon. The habitats where we have found the Wilson's Warbler breeding have been moist or water saturated. However, we have not observed any dependence on the presence of open water which is a habitat requirement reported in the literature (Salt 1973). The destruction of muskegs during mining operations may have a significant local effect on this species, especially if the mining of all surface-mineable deposits is complete.

Interface plot	5	territories/100 ha
Tall bottomland willow plot	4	"
Deciduous shrub fen plot:		
Willow-dominated subplot	69	"
Open bog plot	2	"
Bitumount muskeg (1976)	52	"
Bitumount muskeg (1977)	21	"
Bitumount muskeg: scrub willow subplot	132	"

Canada Warbler (*Wilsonia canadensis*)

Spring Arrival: 29 May

Fall Departure: 22 August

Status: Breeds

Canada Warbler breeding habitat has been characterized by four habitat parameters (whose interrelationships are not clearly understood):

1. The typical forest cover is a mesic deciduous or mixed forest;
2. The forest is at least than 10 m in height;
3. A substantial deciduous shrub layer, which is more than 1.5 m in height, is present under the tree canopy; and
4. The presence of a slope, and this appears to be the limiting factor, approximately 15° or more within the breeding territory.

Whether the effect of the slope is direct or indirect (e.g., the slope in some way alters the vegetation which in turn affects the Canada Warbler) is unknown.

Bitumount aspen forest plot	14	territories/100 ha
Mature mixed forest plot	7	"
River valley mixed forest plot	56	"
Mature balsam poplar/scrub willow	10	"

American Redstart (*Setophaga ruticilla*)

Spring Arrival: 17 May

Fall Departure: early September

Status: Breeds

The American Redstart is a bird of forest edges and open forests. Although not restricted to such situations, it is commonest along interfaces in riparian habitats. The American Redstart hawks insects in midair as well as foraging. Foraging is generally done in deciduous foliage, 2 to 8 m above ground; hawking is done in adjacent open space. Preferred "hawking space" has little or no tree canopy above it. Thus a variety of interface types are suitable for this species: interfaces between deciduous or mixed forests and lakes, rivers or deciduous scrublands; interfaces between tall scrub growth and lakes or rivers. Preferred habitats are those which provide both dense deciduous foliage and open space at all heights between 2 and 8 m above ground; i.e., interfaces between tall deciduous forests and lakes, rivers or land habitats less than 2 m tall.

Bitumount aspen forest plot	3	territories/100 ha
River valley mixed forest plot	6	"
Mature balsam poplar/scrub willow	70	"
LaFont Island	46	"
Hartley Creek valley plot	13	"
Tall bottomland willow plot	56	"

House Sparrow (*Passer domesticus*)

Status: Resident

The House Sparrow is a year-round resident in Fort McMurray and Fort Chipewyan. May and October sightings throughout the study area suggest that the House Sparrow may breed at locations other than these townsites.

7.1.3.26 Blackbirds.

Western Meadowlark (*Sturnella neglecta*)

Spring Arrival: U

Fall Departure: 17 October

Status: Wanderer (Breeds?)

The Western Meadowlark was observed at McClelland Lake on 7 October 1976, heard singing on more than one occasion at the Fort McMurray airport during 1977, and observed on the GCOS site on 17 October 1977. The reported breeding range of this species extends north to the Athabasca region (Salt and Salt 1976). As clearing and strip-mining operations continue, the Western Meadowlark will probably become more common as it colonizes these open areas.

Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*)

Spring Arrival: 9 May - SR

Fall Departure: 23 September - SR

Status: Breeds

The Yellow-headed Blackbird is an uncommon breeder in the study area. This species nests only in cattails or bulrushes along lake shores and marsh edges. Because of the sparsity of this type of habitat within the study area, the Yellow-headed Blackbird is very localized in its distribution.

Red-winged Blackbird (*Agelaius phoeniceus*)

Spring Arrival: 21 April

Fall Departure: 12 October - SR

Status: Breeds

The Red-winged Blackbird utilizes a variety of habitats throughout the study area. In habitats where shrubs dominate, this species prefers a relatively open shrub layer, preferably willow 2 m or taller, growing in a very wet fen or muskeg or an open to dense band of willow occurring along the edge of a lake or marsh. The non-shrub-dominated habitats it prefers are stands of cattails and bulrushes along the edges of lakes and marshes.

Red-winged Blackbirds are loosely colonial. Red-winged Blackbirds are commonly polygynous and recorded female to male ratios have ranged from 1.09:1 to 1.71:1 (Sharp and Richardson 1976).

Sedge fen plot	192 territories/100 ha

Northern Oriole (*Icterus galbula*)

Status: Wanderer

The Northern Oriole occurs sporadically in the study area. It was recorded on LaFont Island on 30 May 1976 and at McClelland Lake on 25 May 1976. It was not observed during 1977. The normal breeding range of the Northern Oriole is thought to extend only as far north as the Athabasca-Cold Lake regions (Godfrey 1966).

Rusty Blackbird (*Euphagus carolinus*)

Spring Arrival: late April

Fall Departure: 23 October - SR

Status: Breeds

The Rusty Blackbird breeds throughout the study area in water-saturated habitats or habitats along the margins of lakes. The Rusty Blackbird will nest in bushes or small conifers (Salt and Salt 1976). Within the study area, the Rusty Blackbird appears to be relatively uncommon.

Tamarack/Muskeg plot	5 territories/100 ha

Brewer's Blackbird (*Euphagus cyanocephalus*)

Spring Arrival: 28 April

Fall Departure: 29 September - SR

Status: Breeds - SR

The Brewer's Blackbird has been observed most often in the Fort McMurray and Syncrude areas. Several individuals which were seen at the (abandoned) Bitumount townsite during 1976 constitute our only other observations for this species. The habitats preferred by the Brewer's Blackbird are the more open areas with bushy tangles nearby, and consequently this species doubtlessly has profited by man's clearing of forests (Godfrey 1966).

Definite breeding territories were recorded on Syncrude Lease 17 (Sharp and Richardson 1976). The normal breeding range of the Brewer's Blackbird is just south of the study area (Godfrey 1966).

Common Grackle (*Quiscalus quiscula*)

Spring Arrival: 19 April

Fall Departure: late September

Status: Breeds

The Common Grackle breeds throughout the study area. It is commonly observed in open, wet habitats such as muskegs, marshes and lakeshores. The Common Grackle usually nests in trees, especially conifers, and may form loose colonies (Salt and Salt 1976). It is not restricted to this nesting niche but will also utilize a wide variety of other nesting sites ranging from cattails to buildings (Salt and Salt 1976).

Sedge fen plot	39 territories/100 ha

Brown-headed Cowbird (*Molothrus ater*)

Spring Arrival: 20 April

Fall Departure: late September

Status: Breeds - G

The Brown-headed Cowbird, which has been observed in a variety of riparian and open habitats, is not an abundant species in the study area. This species is parasitic and will lay its eggs in the nests of other small birds, particularly those birds which nest on the ground or in low bushes (Salt and Salt 1976). The parasitic Cowbirds (*Molothrus*) have definite breeding territories and are usually monogamous (Bent 1958). Due to the lack of vocal territorial behaviour and the concomitant lack of observations, the breeding status of the Cowbird on our study plots is uncertain.

Western Tanager (*Piranga ludoviciana*)

Spring Arrival: 14 May - SR

Fall Departure: mid-August

Status: Breeds

Data from our study plots suggest that the Western Tanager prefers mature mixed forests, especially the more open upland stands where tall spruce or jack pine are present. The males of this species commonly sing from the top portions of these tall conifers. The nest is generally located in a coniferous tree (Godfrey 1966). While the presence of either spruce or jack pine is essential to the Western Tanager, pure coniferous stands do not appear to be utilized. The Western Tanager breeds in suitable habitat throughout the study area.

Aspen-pine plot	7	territories/100 ha
Mature mixed forest plot	19	"
River valley mixed forest plot	8	"
Hartley Creek valley plot	5	"

7.1.3.27 Grosbeaks, Finches, Sparrows, and Buntings.

Rose-breasted Grosbeak (*Pheucticus ludovicianus*)

Spring Arrival: 21 May

Fall Departure: mid-September

Status: Breeds

The Rose-breasted Grosbeak breeds throughout the study area in a variety of habitats. Mature deciduous or mixed forests with a substantial deciduous understory are suitable breeding habitat. An area of tall deciduous or mixed forest adjacent to an area of tall willow with a scattered canopy of taller aspen is an optimal arrangement of habitats for this species. Rose-breasted Grosbeaks are absent from habitats with a wide gap between the deciduous shrub foliage and tree foliage. The males like to sing from tall trees along clearings or interfaces, or from taller trees in shrub-dominated habitats. The nest is located in a tall shrub or tree, usually 1.5 to 4.5 m above ground (Godfrey 1966).

Bitumount aspen plot	15 territories/100 ha
Aspen-pine plot	6 "
Mature mixed forest plot	9 "
Young mixed forest plot	3 "
River valley mixed forest plot	6 "
LaFont Island	14 "
Tall bottomland willow plot	4 "

Evening Grosbeak (*Hesperiphona vespertina*)

Status: Resident - G

Our limited number of observations would suggest that the Evening Grosbeak is an uncommon breeder in the study area. This species was assumed to have bred on the mature mixed forest plot and a female with fledged young was observed in the mature balsam poplar forest on LaFont Island. Observations on the mature mixed forest plot were not of territorial behaviour, however the Evening Grosbeak was stationary on the plot during the breeding season. These observations suggest a preference for mature, preferably mixed, forests. Evening Grosbeak breeding habitat has been described as mixed and coniferous woodlands, including second growths (Godfrey 1966). There is little information on the summer distribution of Evening Grosbeaks in Alberta (Salt and Salt 1976).

Mature mixed forest plot	2 territories/100 ha

Purple Finch (*Carpodacus purpureus*)

Spring Arrival: 26 April

Fall Departure: late August

Status: Breeds

The Purple Finch arrives early in the study area and soon afterwards sets up breeding territories. Preferred breeding habitat seems to be mixed forests which have an open tree canopy or along the interfaces between mixed forests and shorter habitats. During 1976, the Purple Finch bred in an area of mature tamarack fen on the Bitumount muskeg plot (density for this 3 ha subplot was 33 territories/100 ha). Our data suggest that jack pine is not suitable as breeding habitat. Purple Finch breeding habitat has been described as mixed and coniferous woodlands, openings and edges (Godfrey 1966). Although the Purple Finch nests in conifers, it prefers to feed in deciduous trees (Salt and Salt 1976).

Mature mixed forest plot	3 territories/100 ha
Hartley Creek valley plot	5 "
Bitumount muskeg plot	5 "

Pine Grosbeak (*Pinicola enucleator*)

Spring Departure: 27 March
Fall Arrival: 7 October
Status: Winter Resident

The normal breeding range of the Pine Grosbeak is north of the study area, however it may extend as far south as Wood Buffalo Park (Godfrey 1966), which borders part of the study area. As we have not conducted a great deal of field work during the winter months, the abundance of Pine Grosbeaks during this period is not known. Flocks of Pine Grosbeaks were seen regularly from 12 to 31 October (Sharp and Richardson 1976).

Hoary Redpoll (*Carduelis hornemanni*)

Common Redpoll (*Carduelis flammea*)

Spring Departure: early May
Fall Arrival: mid-September
Status: Winter Resident

The migration patterns and habitat requirements of these two species are almost identical and consequently can be discussed together. Both species nest north of the study area, although there have been some records of Common Redpolls nesting in southern Saskatchewan and central Alberta (Salt and Salt 1976). The Hoary Redpoll is the less common of the redpoll species in the study area. Sizes of winter redpoll populations in the study area are probably a function of the severity of the winter and the abundance of food supplies in its summer range. Certain portions of the redpoll populations winter in the study area while others migrate farther south. Redpolls can be found in a variety of habitat types, however they are usually found in open places such as clearings, roads, cutlines or lakeshores where they feed on the seeds of grasses, birch and alder.

Pine Siskin (*Carduelis pinus*)

Spring Arrival: 7 May

Fall Departure: 20 October - W

Status: Breeds

The Pine Siskin is known to breed throughout the study area (Godfrey 1966), however, it occurred as a breeding species on only one of our plots. Singing males were heard in an open stand of overmature, pine-dominated, mixed forest on the mature mixed forest plot. Wandering flocks of Siskins abound in the summer, and are most often seen in pure coniferous or conifer-dominated habitats. Strong social behaviour is evident throughout the year and during the breeding season several pairs may form a loose colony in which territorial aggressiveness is only evident in the immediate vicinity of the nest (Salt and Salt 1976). Observations on our other plots were in most cases sporadic and of wandering flocks and consequently the lack of observations of singing males suggests that Siskins did not breed on these plots.

American Goldfinch (*Carduelis tristis*)

Status: Wanderer (Breeds?)

The American Goldfinch, whose normal breeding range is south of Athabasca (Godfrey 1966), was observed at Fort MacKay, Fort McMurray and Thickwood Hills Tower.

Red Crossbill (*Loxia curvirostra*)

Status: Resident

Observations of the Red Crossbill within the study area have been sporadic. Throughout its entire range, the appearance and length of stay are unpredictable and governed to a large extent by the availability of its staple food, conifer seeds (Godfrey 1966; Salt and Salt 1976). Nesting is equally unpredictable and may occur at any time of the year (Godfrey 1966).

White-winged Crossbill (*Loxia leucoptera*)

Status: Resident

Substantiated breeding territories of the White-winged Crossbill have not occurred on any of our study plots, although singing males were recorded on the mature mixed forest plot. Like the Red Crossbill, the White-winged is unpredictable in its occurrence, duration of stay and nesting (Godfrey 1966). The White-winged Crossbill has been observed in a variety of mature, coniferous-dominated habitats.

Savannah Sparrow (*Passerculus sandwichensis*)

Spring Arrival: 8 May

Fall Departure: 20 September

Status: Breeds

The Savannah Sparrow breeds throughout the study area in the more open habitats. Open tamarack muskegs, bog birch muskegs, and sedge/grass-dominated fens are typical breeding habitats within the study area. Salt and Salt (1976) found that "practically any meadow will attract Savannah sparrows, providing the grass is long enough", however this is not the case in the oil sands area. The occurrence of this species was sporadic and large expanses of apparently suitable habitat were not utilized. Our data and the literature (Godfrey 1966; Salt and Salt 1976) both indicate a preference for moist or water-saturated sites.

Tamarack muskeg plot	18 territories/100 ha

LeConte's Sparrow (*Ammospiza leconteii*)

Spring Arrival: 5 May

Fall Departure: 20 September

Status: Breeds

The breeding habitat of the LeConte's Sparrow can be described as a poorly drained or saturated site which is dominated by sedges and low deciduous shrubs. Observations of singing males on the open bog plot suggested a preference for the ecotone between small sedge clearings and the surrounding 0.75 m tall swamp birch. This habitat relationship was also evident on the tall bottomland willow plot where singing males were associated with the 2 to 4 m tall willow which was situated around the perimeters of wet sedge meadows. The nest may be on the ground, a few centimetres above it in a clump of dead grass or in the base of a bush in marshy areas (Godfrey 1966; Salt and Salt 1976).

Tall bottomland willow plot	4	territories/100 ha
Deciduous shrub fen plot	17	"
Open bog plot	38	"
Bitumount muskeg plot (1977)	2	"

Sharp-tailed Sparrow (*Ammospiza caudacuta*)

Spring Arrival: 16 May

Fall Departure: mid-September

Status: Breeds

Sharp-tailed Sparrows have bred on only one of the study plots, the Bitumount muskeg plot, and consequently we do not have a great deal of data on habitat preferences in the study area. During 1976, the territories of the Sharp-tailed Sparrow were located in a water-saturated (water table above soil) area which was dominated by tamarack in Stratum 3, scattered swamp birch in Stratum 2, and dense sedge and swamp birch in Stratum 1. During 1977, Sharp-tailed Sparrows did not breed in this area and reduced water levels may have been the cause of this abandonment. Margins of pools, lakes, marshes, wet grassy meadows, and other wet habitats are described as typical breeding habitat (Godfrey 1966; Salt and Salt 1976).

Bitumount muskeg plot (1976)	3	territories/100 ha

Vesper Sparrow (*Pooecetes gramineus*)

Spring Arrival: 6 May

Fall Departure: U

Status: Breeds - G, SR

Observations of the Vesper Sparrow indicate that its occurrence in the study area is limited at the present time. Vesper Sparrows have been reported breeding on and in the vicinity of Syncrude Lease 17 (Sharp and Richardson 1976). This species probably breeds at airstrips throughout the area. The typical breeding habitat of the Vesper Sparrow has been described as pastures, prairies, roadsides, gravel pits, and similar dry, grassy places (Godfrey 1966). Consequently, the mining operations and the subsequent reclamation of mined areas should create open habitats which will be to the liking of this species and the abundance of the Vesper Sparrow within the study area may increase over the next few decades.

Dark-eyed Junco (*Junco hyemalis*)

Spring Arrival: 11 April

Fall Departure: 14 October

Status: Breeds

The Dark-eyed Junco (Slate-colored) breeds throughout the entire study area in forested habitats which have some coniferous trees present. One or two spruce in an aspen forest is a sufficient density of conifers to attract at least one breeding pair. From information obtained through the subplot analysis of its distribution, the Dark-eyed Junco will probably be found in greatest densities (approximately 50 territories per 100 ha) in areas of very dense young black spruce. Singing males seem to prefer the tops of conifers, edges of clearings and other open situations. The nest is on or near the ground and usually concealed by vegetation (Godfrey 1966). The drainage of a site does not appear to affect this species. During migration this species can be found in a variety of habitats.

Bitumount aspen forest plot	3	territories/100 ha
McClelland aspen forest plot	5	"
Aspen-pine forest plot	17	"
Mature jack pine plot	8	"
Young jack pine plot	9	"
Mature mixed forest plot	5	"
Young mixed forest plot	18	"
River valley mixed forest plot	5	"

Hartley Creek valley plot	3	territories/100 ha
Interface plot	11	"
Young black spruce plot	23	"
Mature black spruce plot	20	"
Bitumount muskeg plot (1976)	12	"
Bitumount muskeg plot (1977)	8	"

Tree Sparrow (*Spizella arborea*)

Spring Arrival: 15 April

Spring Departure: 20 May - SR

Fall Arrival: 15 September

Fall Departure: 9 October

Status: Migrant

The Tree Sparrow is a common migrant through the study area and frequents a wide variety of habitats during both migration periods. The Tree Sparrow migrates to breeding grounds north of the study area (Salt and Salt 1976). During migration the Tree Sparrow is typically associated with habitats which are relatively open (i.e., clearings, cutlines) but still provide dense shrubbery close by.

Chipping Sparrow (*Spizella passerina*)

Spring Arrival: 13 May

Fall Departure: 23 September - SR

Status: Breeds

The Chipping Sparrow was present on all the study plots with the exceptions of LaFont Island, the deciduous shrub/fen plot, and the sedge fen plot. This species prefers mixed or coniferous forests but will breed in deciduous-dominated forests if there is even a small percentage of conifers. Forests in which the height diversity (but not necessarily foliage height diversity) is considerable seem to be preferred breeding habitat. Situations where height differences occur, such as the edges of clearings, or ecotones between habitats of varying heights, will be the favoured location for singing males. However, the location of the nest is usually less than 3 m above the ground in either a deciduous or coniferous shrub or tree (Godfrey 1966). Consequently the type of tree canopy, its openness, and its height variability determine the value of the habitat for territorial displays. Maximum densities of approximately 70 territories per 100 ha may occur in prime habitats such as an open mature mixed forest.

Bitumount aspen plot	13	territories/100 ha
McClelland aspen forest plot	5	"
Aspen-pine forest plot	20	"
Mature jack pine plot	23	"
Young jack pine plot	24	"
Mature mixed forest plot	62	"
Young mixed forest plot	20	"
River valley mixed forest plot	22	"
Mature balsam poplar/scrub willow plot	21	"
Hartley Creek valley plot	9	"
Interface plot	10	"
Tall bottomland willow plot	2	"
Open bog plot	6	"
Young black spruce plot	17	"
Mature black spruce plot	35	"
Bitumount muskeg plot (1976)	48	"
Bitumount muskeg plot (1977)	33	"
Tamarack muskeg plot	44	"

Clay-colored Sparrow (*Spizella pallida*)

Spring Arrival: 16 May
Fall Departure: Mid-September
Status: Breeds

Deciduous shrub habitats, in which willow forms some percentage of the canopy, have been the observed breeding habitats of the Clay-colored Sparrow. This species seems to have a preference for shorter (less than 3 m), scattered or open willow as opposed to taller, dense willow. In addition to willow, alder and rose along streams, edges of ponds, lakes or swamps have been described as suitable habitat (Godfrey 1966). While we have found no preference for alder and rose, we have found a decided preference for the wet habitats such as muskegs and fens. Clay-colored Sparrow densities in drier habitats, such as sandbar or bottomland willow habitats, are much lower. Subplot analysis reveals that densities in excess of 150 territories per 100 ha could occur in prime habitat such as open, scrub willow with a sedge/forb ground stratum and water-saturated soil. The nest is generally located in a deciduous shrub (Godfrey 1966). While the present population in the study area appears to be restricted to the wetter habitats, this does not preclude the colonization of reclaimed sites which we suspect will be dry. Dry prairie with scattered shrubbery is the breeding habitat of the Clay-colored Sparrow south of the boreal forest.

LaFont Island	2	territories/100 ha
Tall bottomland willow plot	2	"
Deciduous shrub fen plot	72	"
Open bog plot	31	"
Bitumount muskeg plot (1976)	46	"
Bitumount muskeg plot (1977)	43	"

Harris's Sparrow (*Zonotrichia querula*)

Spring Arrival: 21 May
Spring Departure: U
Fall Arrival: U
Fall Departure: 26 September
Status: Migrant

The Harris's Sparrow is an uncommon migrant through the study area. Its breeding range is north of Alberta and the majority of the population follows a migration route through Saskatchewan and Manitoba (Godfrey 1966).

White-crowned Sparrow (*Zonotrichia leucophrys*)

Spring Arrival: 13 May

Fall Departure: 1 October

Status: Breeds - G

Observations of the White-crowned Sparrow during spring and fall migration have been scarce. We have not come across any information which suggests that this species breeds in the southern half of the study area, although breeding distribution maps show the normal range to include the northern portion of the study area (Godfrey 1966; Salt and Salt 1976). The breeding habitat of this species is described as woody shrubbery and thickets in more open situations (Godfrey 1966).

White-throated Sparrow (*Zonotrichia albicollis*)

Spring Arrival: 7 May

Fall Departure: 25 October

Status: Breeds

The White-throated Sparrow breeds in a wide variety of habitat types throughout the study area. A tall (2 to 6 m), open to dense, deciduous or mixed shrublayer appears to be the preferred habitat of the White-throated Sparrow. This species uses willow, spruce and alder; however, the highest breeding densities have been recorded in willow-dominated habitats. Shrub-dominated habitats, with or without a scattered tree canopy, appear to be preferred to habitats with an open to closed tree canopy. Open, mixed-tree canopies are preferred to pure, dense or closed tree canopies. A dense or closed aspen canopy, even with a substantial shrublayer, appears to severely limit or even exclude the White-throated Sparrow. The literature lists this species' preference as bushy openings or edges of woodlands (Godfrey 1966). Thus considerable densities could also be expected in an open mixed forest/willow upland ecotone.

Aspen-pine forest plot	20	territories/100 ha
Mature mixed forest plot	16	"
Young mixed forest plot	5	"
River valley mixed forest plot	13	"

Mature balsam poplar/scrub willow plot	23 territories/100 ha
LaFont Island	18 "
Hartley Creek valley plot	31 "
Interface plot	31 "
Tall bottomland willow plot	65 "
Deciduous shrub fen plot	2 "
Young black spruce plot	28 "
Bitumount muskeg plot (1976)	55 "
Bitumount muskeg plot (1977)	55 "

Fox Sparrow (*Passerella iliaca*)

Spring Arrival: 21 April

Fall Departure: mid-October

Status: Breeds

The Fox Sparrow breeds throughout the study area. Breeding territories of this species are most often associated with edge situations (e.g., shrub upland/forest interfaces and especially willow/water interfaces). Greatest densities in the study area have been recorded in an area of mature willow with numerous oxbows and a meandering river. Observations of the Fox Sparrow during the breeding season have been totally confined to deciduous habitats. In other areas of Canada, coniferous forests are described as suitable habitat (Godfrey 1966). The nest is usually located on the ground or low in a tree (Salt and Salt 1976).

Mature balsam poplar/scrub willow plot	7 territories/100 ha
LaFont Island	4 "
Tall bottomland willow plot	46 "

Lincoln's Sparrow (*Melospiza lincolnii*)

Spring Arrival: 13 May

Fall Departure: 29 September

Status: Breeds

The Lincoln's Sparrow breeds throughout the study area in muskegs, fens, marshes, streamsides and other wet places. Any wet habitat is suitable if it provides deciduous shrubs taller than 0.5 m. Suitability increases with increasing dominance of the deciduous component. This species has been found in greatest densities in an area dominated by swamp birch (averaging less than 1 m in height) and sedges. This is the preferred breeding habitat and extensive areas of it are not essential. Small clearings of this habitat in coniferous-dominated muskegs will usually attract one or two pairs. Other areas dominated by deciduous shrubs, typically willow, are utilized as breeding habitat but population densities are lower. A dense carpet of moss has been characteristic of the plots which supported substantial breeding populations. When available, dead spars are frequently used as singing posts.

Young mixed forest plot	1	territory/100 ha
River valley mixed forest plot	3	"
Interface plot	5	"
Tall bottomland willow plot	7	"
Deciduous shrub fen plot	35	"
Open bog plot	122	"
Sedge fen plot	21	"
Young black spruce plot	5	"
Mature black spruce plot	12	"
Bitumount muskeg plot (1976)	50	"
Bitumount muskeg plot (1977)	46	"
Tamarack muskeg plot	63	"

Swamp Sparrow (*Melospiza georgiana*)

Spring Arrival: 13 May

Fall Departure: 3 October

Status: Breeds

A deciduous shrub-dominated Stratum 2, Stratum 1 dominated by sedge, and a water table at or above ground level are the characteristics of Swamp Sparrow breeding habitat. Areas in which the water table is at the soil surface during the spring but subsequently drops to leave a dry soil surface are also used, but breeding densities are generally lower. Willow, 1 to 3 m in height, seems to be a preferred shrub, although swamp birch taller than 1 m is also utilized. Alder is apparently unsuitable for the Swamp Sparrow. Willow-sedge fens or sedge fen which are bordered by willow are preferred habitats, where very high densities can be expected. This habitat description is similar to breeding habitat described elsewhere in Canada (Godfrey 1966). Observations on the open bog plot suggest that dense stands of dead willow will be used as breeding habitat. The nest is located on the ground or low in a bush (Godfrey 1966).

Tall bottomland willow plot	11	territories/100 ha
Deciduous shrub fen plot	88	"
Open bog plot	38	"
Sedge fen plot	116	"
Bitumount muskeg plot (1976)	17	"
Bitumount muskeg plot (1977)	13	"
Willow-dominated subplot of the deciduous shrub fen plot	237	"

Song Sparrow (*Melospiza melodia*)

Spring Arrival: 20 April

Fall Departure: U

Status: Breeds

The Song Sparrow, which breeds throughout the study area, is most commonly found in stands of willow which border a stream or river. We have not observed territorial males in habitats other than riparian ones. Dense stands of willow 2 to 4 m tall appear to be preferred habitat. Extensive stands are not required, a narrow band of dense willow on a river bank seems to be acceptable breeding habitat. Although we have found the Song Sparrow to be strictly associated with riparian habitats, this sparrow can be found in a variety of bushy, edge situations elsewhere in its range (Godfrey 1966). The nest is usually located on the ground, occasionally in a bush or tree (Salt and Salt 1976).

River valley mixed forest plot	14 territories/100 ha
Mature balsam poplar/scrub willow plot	22 "
LaFont Island	35 "
Tall bottomland willow plot	11 "

Lapland Longspur (*Calcarius lapponicus*)

Spring Arrival: U
Spring Departure: 18 May
Fall Arrival: early September
Fall Departure: mid-November
Status: Migrant

During spring migration the Lapland Longspur quickly moves through the study area on its way to its breeding grounds in the far north. However fall migration occurs at a much slower rate and flocks of birds appear to linger in suitable habitat. Cutlines, road edges, vegetated sandbars, natural and man-made clearings and other open, weedy and grassy habitats are typical stopover locations where this species will rest and forage for seeds. Cleared and strip-mined areas, both during the mining operation and afterwards, may attract Lapland Longspurs, however these habitats and the operations conducted there should not create any hazards. The shores of tailings ponds may be a more significant danger depending on the construction. Steep banks and the concomitant lack of a littoral zone will deter this species from the shorelines of tailings ponds, and consequently keep it from fouling itself with the bitumen which occurs in the tailings.

Smith's Longspur (*Calcarius pictus*)

Spring Arrival: U
Spring Departure: U
Fall Arrival: 24 August
Fall Departure: 4 September
Status: Migrant

The Smith's Longspur, which breeds in the Arctic, is a rare fall migrant and has not been observed during spring migration.

During 1976, 15 individuals were observed on the Bitumount airstrip. Several observations of this species were made in the area of the Shell Test Pit during September 1977.

Chestnut-collared Longspur (*Calcarius ornatus*)

Status: Wanderer

A pair of Chestnut-collared Longspurs was observed at Fort MacKay on 20 May 1976 (Rainer Ebel, pers. comm. 1976). The normal breeding range of this species is well south of the study area in the short-grass prairies of Alberta (Salt 1976).

Snow Bunting (*Plectrophenax nivalis*)

Spring Arrival: 15 April

Spring Departure: 6 May

Fall Arrival: 19 September

Fall Departure: mid-November

Status: Migrant

This species migrates through the area and during migration it is found along cutlines and clearings. Migrating flocks in the fall linger in the area for a longer period than do the spring flocks. Implications of oil sands development are much the same for the Snow Bunting as they are for the Lapland Longspur.

7.2 1976 AND 1977 BREEDING BIRD RESULT

The densities of breeding birds in thirty habitat types in the Athabasca Oil Sands region for 1976 and 1977 are given in the following tables.

Table 21. Bitumount aspen forest plot breeding bird data (1976).

Species	Density
Broad-winged Hawk	BR[a]
Spruce Grouse	0.04 observations/km (PR)[b]
Ruffed Grouse	0.32 observations/km
Common Flicker	CL[c]
Yellow-bellied Sapsucker	PR
Least Flycatcher	103 territories/100 ha
Black-capped Chickadee	5 "
Hermit Thrush	14 "
Swainson's Thrush	24 "
Red-eyed Vireo	47 "
Philadelphia Vireo	3 "
Black-and-White Warbler	9 "
Tennessee Warbler	53 "
Ovenbird	148 "
Canada Warbler	14 "
American Redstart	3 "
Western Tanager	PR
Rose-breasted Grosbeak	15 "
Pine Siskin	PR
Dark-eyed Junco	3 "
Chipping Sparrow	13 "
White-throated Sparrow	1 "
	"
Total No. Territories	452 territories/100 ha
Species Richness	16
C.I.N.	11

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[a] BR - Presence indicated and species observed to breed in similar habitat beyond plot boundaries.

[b] PR - Presence indicated; however, status on the plot and in similar habitat is as a visitor, a non-breeder.

[c] CL - Cluster involving insufficient numbers of observations for ratification of territory by IBCC (1970) standards. standards.

Table 22. McClelland aspen forest plot breeding bird data (1976).

Species	Density	
Ruffed Grouse	0.13 observations/km	
Least Flycatcher	9	territories/100 ha
Gray Jay	PR	
Black-capped Chickadee	2	"
Hermit Thrush	7	"
Swainson's Thrush	CL	
Red-eyed Vireo	15	"
Philadelphia Vireo	2	"
Black-and-white Warbler	2	"
Tennessee Warbler	47	"
Bay-breasted Warbler	CL	
Ovenbird	48	"
Rose-breasted Grosbeak	CL	
Dark-eyed Junco	5	"
Chipping Sparrow	5	"
White-throated Sparrow	CL	
Total No. Territories	142	territories/100 ha
Species Richness	11	
C.I.N.	4	

Table 23. Aspen-jack pine forest plot breeding bird data (1977).

Species	Density
Spruce Grouse	0.22 observations/km
Ruffed Grouse	0.02 " "
Common Flicker	3 territories/100 ha
Yellow-bellied Sapsucker	6
Hairy Woodpecker	2 "
Black-backed Three-toed Woodpecker	CL
Northern Three-toed Woodpecker	1 "
Least Flycatcher	CL
Western Wood Pewee	7 "
Olive-sided Flycatcher	2 "
Gray Jay	3 "
Black-capped Chickadee	2 "
Boreal Chickadee	2 "
Red-breasted Nuthatch	8 "
Hermit Thrush	10 "
Swainson's Thrush	6 "
Solitary Vireo	6 "
Red-eyed Vireo	8 "
Tennessee Warbler	31 "
Orange-crowned Warbler	9 "
Yellow-rumped Warbler	13 "
Ovenbird	18 "
Conneticut Warbler	CL
Western Tanager	7 "
Rose-breasted Grosbeak	6 "
Pine Siskin	PR
Dark-eyed Junco	17 "
Chipping Sparrow	20 "
White-throated Sparrow	20 "
Total No. Territories	206 territories/100 ha
Species Richness	24
C.I.N.	13

Table 24. Young jack pine forest plot breeding bird data (1976).

Species	Density
Goshawk	PR
Spruce Grouse	0.14 observations/km
Olive-sided Flycatcher	PR
Gray Jay	PR
American Robin	1 territory/100 ha
Hermit Thrush	9 "
Swainson's Thrush	7 "
Solitary Vireo	4 "
Tennessee Warbler	3 "
Yellow-rumped Warbler	30 "
Dark-eyed Junco	9 "
Chipping Sparrow	24 "
Total No. Territories	86 territories/100 ha
Species Richness	9
C.I.N.	4

Table 25. Mature jack pine forest plot breeding bird data (1976).

Species	Density
Common Nighthawk	2 territories/100 ha
Black-backed Three-toed Woodpecker	BR
Northern Three-toed Woodpecker	2 "
Gray Jay	4 "
Boreal Chickadee	4 "
Red-breasted Nuthatch	CL
American Robin	CL
Solitary Vireo	CL
Yellow-rumped Warbler	24 "
Western Tanager	CL
Dark-eyed Junco	8 "
Chipping Sparrow	23 "
Total No. Territories	67 territories/100 ha
Species Richness	7
C.I.N.	6

Table 26. Young mixed forest plot breeding bird data (1977).

Species	Density
Spruce Grouse	0.46 observations/km
Ruffed Grouse	0.05 " " (PR)
Great Horned Owl	PR
Common Flicker	2 territories/100 ha
Pileated Woodpecker	1 "
Yellow-bellied flycatcher	10 "
Alder Flycatcher	CL
Western Wood Pewee	PR
Gray Jay	12 "
Boreal Chickadee	2 "
Red-breasted Nuthatch	PR
Hermit Thrush	10 "
Swainson's Thrush	26 "
Ruby-crowned Kinglet	PR
Solitary Vireo	5 "
Red-eyed Vireo	2 "
Black-and-white Warbler	20 "
Tennessee Warbler	27 "
Magnolia Warbler	3 "
Yellow-rumped Warbler	38 "
Bay-breasted Warbler	4 "
Ovenbird	32 "
Western Tanager	PR
Rose-breasted Grosbeak	3 "
Dark-eyed Junco	18 "
Chipping Sparrow	20 "
White-throated Sparrow	5 "
Lincoln's Sparrow	1 "
Total No. Territories	230 territories/100 ha
Species Richness	22
C.I.N.	10

Table 27. Mature mixed forest plot breeding bird data (1976).

Species	Density
Spruce Grouse	0.04 observations/km (PR)
Ruffed Grouse	0.19 "
Common Flicker	7 territories/100 ha
Pileated Woodpecker	2 "
Yellow-bellied Sapscuker	24 "
Hairy Woodpecker	2 "
Least Flycatcher	22 "
Western Wood Pewee	4 "
Gray Jay	5 "
Blue Jay	3 "
Black-capped Chickadee	2 "
Boreal Chickadee	5 "
Red-breasted Nuthatch	11 "
Winter Wren	11 "
Hermit Thrush	BR
Swainson's Thrush	52 "
Ruby-crowned Kinglet	3 "
Solitary Vireo	5 "
Red-eyed Vireo	17 "
Warbling Vireo	3 "
Black-and-white Warbler	6 "
Tennessee Warbler	103 "
Orange-crowned Warbler	1 "
Magnolia Warbler	6 "
Cape May Warbler	6 "
Yellow-rumped Warbler	25 "
Bay-breasted Warbler	19 "
Ovenbird	31 "
Mourning Warbler	3 "
Canada Warbler	7 "
Western Tanager	19 "
Rose-breasted Grosbeak	9 "
Evening Grosbeak	2 "
Purple Finch	3 "
Pine Siskin	6 "
White-winged Crossbill	CL
Dark-eyed Junco	5 "
Chipping sparrow	62 "
White-throated Sparrow	16 "
Total No. Territories	515 territories/100 ha
Species Richness	36
C.I.N.	21

Table 28. River valley mixed forest-river transect breeding bird data (1976).

Species	Density
American Kestrel	PR
Spruce Grouse	0.07 observations/km
Ruffed Grouse	0.07 "
Kildeer	PR
Spotted Sandpiper	7 territories/100 ha (0.7 territories/km)
Greater Yellowlegs	PR
Common Flicker	8 "
Pileated Woodpecker	CL
Yellow-bellied Sapsucker	14 "
Hairy Woodpecker	3 "
Eastern Pheobe	3 "
Alder Flycatcher	PR
Least Flycatcher	6 "
Western Wood Pewee	1 "
Gray Jay	6 "
Black-capped Chickadee	5 "
Boreal Chickadee	CL
Red-breasted Nuthatch	CL
American Robin	7 "
Hermit Thrush	3 "
Swainson's Thrush	27 "
Ruby-crowned Kinglet	2 "
Red-eyed Vireo	49 "
Black-and-white Warbler	24 "
Tennessee Warbler	45 "
Orange-crowned Warbler	CL
Yellow Warbler	5 (0.7 territories/km)
Magnolia Warbler	14 "
Cape May Warbler	3 "
Yellow-rumped Warbler	8 "
Bay-breasted Warbler	6 "
Ovenbird	27 "
Northern Waterthrush	6 (1.0 territories/km)
Mourning Warbler	18 "
Canada Warbler	56 "
American Redstart	6 "
Western Tanager	8 "
Rose-breasted Grosbeak	6 "
Evening Grosbeak	PR

Table 28. Continued.

Species	Density
Pine Siskin	PR
Dark-eyed Junco	5 territories/100 ha
Chipping Sparrow	22 "
White-throated Sparrow	13 "
Lincoln's Sparrow	3 "
Song Sparrow	14 (2.1 territories/km)
Total No. Territories	430 territories/100 ha
Species Richness	34
C.I.N.	16

Table 29. LaFont Island breeding bird data (1976).

Species	Density	
American Kestrel	BR	
Ruffed Grouse	0.27	observations/km
Spotted Sandpiper	4	territories/100 ha
Belted Kingfisher	PR	
Common Flicker	4	"
Yellow-bellied Sapsucker	4	"
Hairy Woodpecker	PR	
Alder Flycatcher	10	"
Least Flycatcher	32	"
Tree Swallow	PR	
Black-billed Magpie	PR	
Common Raven	2	"
Black-capped Chickadee	PR	
American Robin	8	"
Swainson's Thrush	22	"
Red-eyed Vireo	12	"
Philadelphia Vireo	20	"
Black-and-white Warbler	10	"
Tennessee Warbler	60	"
Yellow Warbler	22	"
Ovenbird	12	"
Northern Waterthrush	44	"
Mourning Warbler	10	"
American Redstart	46	"
Brown-headed Cowbird	PR	"
Rose-breasted Grosbeak	14	"
Evening Grosbeak	CL	
Clay-colored Sparrow	2	"
White-throated Sparrow	18	"
Fox Sparrow	4	"
Song Sparrow	35	"
Total No. Territories	395	territories/100 ha
Species Richness	23	
C.I.N.	12	

Table 30. Mature balsam poplar/scrub willow-river transect breeding bird data and subplot data (1976).

Species	territories/100 ha		territories/km	
		subplot[a]	forest/ scrub	scrub/ river
American Kestrel	2	2		
Ruffed Grouse	BR			
Spotted Sandpiper	1			
Greater Yellowlegs	PR			
Great Horned Owl	2	4		
Common Flicker	4			
Yellow-bellied Sapsucker	CL			
Hairy Woodpecker	6	2		
Alder Flycatcher	PR			
Least Flycatcher	107	158	10.7	
Gray Jay	PR			
Common Raven	2	2		
Black-capped Chickadee	4			
American Robin	9	7	0.7	
Swainson's Thrush	38	40	4.7	
Red-eyed Vireo	56	57	5.7	
Warbling Vireo	6	12		
Black-and-white Warbler	7	20	1.3	
Tennessee Warbler	18	27	2.7	
Yellow Warbler	53	72	3.7	5.2
Magnolia Warbler	PR			
Black-throated Green Warbler	2	5		
Ovenbird	3			
Northern Waterthrush	44	64	6.7	0.3
Mourning Warbler	20	20	0.7	
Canada Warbler	10	5		
American Redstart	70	45	7.3	
Brown-headed Cowbird	PR			
Evening Grosbeak	PR			
Chipping Sparrow	21	35	0.2	
White-throated Sparrow	20	17	1.3	
Fox Sparrow	7	10		1.3
Song Sparrow	22	25	0.3	3.1
Total No. Territories	545	634	47.7	9.8
Species Richness	26	22		
C.I.N.	N/A	N/A		

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[a] Forest, ecotone and willow scrub subplot (10 ha).

Table 31. Tall bottomland willow plot breeding bird data (1977).

Species	Density	
Mallard	7	territories/100 ha
Green-winged Teal	PR	
Blue-winged Teal	4	"
American Wigeon	7	"
Goshawk	PR	
Sharp-shinned Hawk	PR	
Ruffed Grouse	0.46	observations/km
Common Snipe	4	territories/100 ha
Common Flicker	2	"
Alder Flycatcher	12	"
Least Flycatcher	4	"
Gray Jay	4	"
Black-billed Magpie	2	"
Black-capped Chickadee	4	"
Red-breasted Nuthatch	PR	
American Robin	15	"
Swainson's Thrush	38	"
Red-eyed Vireo	6	"
Philadelphia Vireo	15	"
Black-and-white Warbler	28	"
Tennessee Warbler	49	"
Yellow Warbler	5	"
Blackpoll Warbler	6	"
Ovenbird	9	"
Northern Waterthrush	62	"
Mourning Warbler	BR	
Wilson's Warbler	4	"
American Redstart	56	"
Rose-breasted Grosbeak	4	"
LeConte's Sparrow	4	"
Chipping Sparrow	5	"
Clay-colored Sparrow	2	"
White-throated Sparrow	65	"
Fox Sparrow	46	"
Lincoln's Sparrow	7	"
Swamp Sparrow	11	"
Song Sparrow	11	"
Total No. Territories	499	territories/100 ha
Species Richness	32	
C.I.N.	16	

Table 32. Hartley Creek valley plot breeding bird data (1977).

Species	Density
Common Merganser	2 territories/100 ha
Sharp-shinned Hawk	BR
American Kestrel	3 "
Spotted Sandpiper	6 "
Spruce Grouse	0.25 observations/km
Ruffed Grouse	0.45 "
Great Horned Owl	2 territories/100 ha
Common Flicker	3 "
Alder Flycatcher	19 "
Least Flycatcher	BR
Gray Jay	8 "
Black-capped Chickadee	CL
Boreal Chickadee	PR
Red-breasted Nuthatch	PR
Hermit Thrush	2 "
Swainson's Thrush	30 "
Ruby-crowned Kinglet	3 "
Red-eyed Vireo	BR
Philadelphia Vireo	16 "
Black-and-white Warbler	33 "
Tennessee Warbler	75 "
Yellow Warbler	CL
Magnolia Warbler	19 "
Yellow-rumped Warbler	6 "
Ovenbird	8 "
Northern Waterthrush	31 "
Mourning Warbler	20 "
American Redstart	13 "
Western Tanager	5 "
Rose-breasted Grosbeak	BR
Purple Finch	5 "
Pine Siskin	PR
Dark-eyed Junco	3 "
Chipping Sparrow	9 "
White-throated Sparrow	31 "
Total No. Territories	352 territories/100 ha
Species Richness	26
C.I.N.	15

Table 33. Interface plot breeding bird data (1977).

Species	Density
Spruce Grouse	0.42 observations/km
Ruffed Grouse	0.03 "
Yellow-bellied Flycatcher	7 territories/100 ha
Alder Flycatcher	9 "
Gray Jay	3 "
Black-capped Chickadee	3 "
Red-breasted Nuthatch	3 "
Hermit Thrush	9 "
Swainson's Thrush	17 "
Ruby-crowned Kinglet	CL
Solitary Vireo	13 "
Red-eyed Vireo	9 "
Philadelphia Vireo	BR
Black-and-white Warbler	12 "
Tennessee Warbler	76 "
Magnolia Warbler	1 "
Cape May Warbler	BR
Yellow-rumped Warbler	10 "
Palm Warbler	8 "
Ovenbird	45 "
Wilson's Warbler	5 "
Purple Finch	PR
Dark-eyed Junco	11 "
Chipping Sparrow	10 "
Clay-colored Sparrow	BR
White-throated Sparrow	31 "
Lincoln's Sparrow	5 "
Total No. Territories	289 territories/100 ha
Species Richness	21
C.I.N.	N/A

Table 34. Deciduous shrub fen plot breeding bird data (1977).

Species	Density	
Common Snipe	12	territories/100 ha
Alder Flycatcher	18	"
Black-capped Chickadee	BR	
American Robin	2	"
Black-and-white Warbler	BR	
Tennessee Warbler	3	"
Yellow Warbler	2	"
Blackpoll Warbler	1	"
Palm Warbler	6	"
Northern Waterthrush	BR	
Common Yellowthroat	74	"
Wilson's Warbler	22	"
American Redstart	BR	
LeConte's Sparrow	17	"
Chipping Sparrow	PR	
Clay-colored Sparrow	72	"
White-throated Sparrow	2	"
Lincoln's Sparrow	35	"
Swamp Sparrow	88	"
Total No. Territories	358	territories/100 ha
Species Richness	14	
C.I.N.	8	

Table 35. Open bog plot breeding bird data (1977).

Species	Density
American Kestrel	CL
Sharp-tailed Grouse	1 dancing ground of 7 birds
Sandhill Crane	BR
Common Snipe	9 territories/100 ha.
Lesser Yellowlegs	3 "
Common Flicker	3 "
Eastern Kingbird	CL
Alder Flycatcher	3 "
Gray Jay	8 "
Palm Warbler	13 "
Common Yellowthroat	BR
Wilson's Warbler	2 "
Red-winged Blackbird	BR
Common Grackle	PR
LeConte's Sparrow	38 "
Chipping Sparrow	6 "
Clay-colored Sparrow	31 "
Lincoln's Sparrow	122 "
Swamp Sparrow	38 "
Total No. Territories	273 territories/100 ha.
Species Richness	12 "
C.I.N.	8

Table 36. Sedge fen breeding bird data (1976).

Species	Density
Sora	68 territories/100 ha
Greater Yellowlegs	11
Yellow Warbler	26 (1.5 territories/km)
Common Yellowthroat	5 (.3 ")
Red-winged Blackbird	192 (9.5 ")
Common Grackle	39 (2.0 ")
Lincoln's Sparrow	21 (1.0 ")
Swamp Sparrow	116
Total No. Territories	479 (14.3 territories/km)
Species Richness	8
C.I.N.	6

Table 37. Young black spruce breeding bird data (1977).

Species	Density
Spruce Grouse	0.10 observations/km
Ruffed Grouse	0.02 "
Common Snipe	1 territory/100 ha
Greater Yellowlegs	1 "
Common Flicker	2 "
Yellow-bellied Flycatcher	8 "
Alder Flycatcher	BR
Gray Jay	9 "
Common Raven	PR
Boreal Chickadee	9 "
Red-breasted Nuthatch	PR
Hermit Thrush	1 "
Swainson's Thrush	19 "
Ruby-crowned Kinglet	10 "
Solitary Vireo	3 "
Black-and-white Warbler	4 "
Tennessee Warbler	8 "
Yellow-rumped Warbler	17 "
Blackpoll Warbler	2 "
Palm Warbler	68 "
Dark-eyed Junco	23 "
Chipping Sparrow	17 "
White-throated Sparrow	28 "
Lincoln's Sparrow	5 "
Total No. Territories	233 territories/100 ha
Species Richness	20
C.I.N.	6

Table 38. Mature black spruce breeding bird data (1977).

Species	Density
Spruce Grouse	0.32 observations/km
Solitary Sandpiper	PR
Common Flicker	5 territories/100 ha
Yellow-bellied Sapsucker	PR
Hairy Woodpecker	6 "
Northern Three-toed Woodpecker	6 "
Western Wood Pewee	21 "
Olive-sided Flycatcher	11 "
Gray Jay	9 "
Boreal Chickadee	9 "
Red-breasted Nuthatch	PR
Swainson's Thrush	9 "
Ruby-crowned Kinglet	17 "
Orange-crowned Warbler	PR
Magnolia Warbler	PR
Yellow-rumped Warbler	32 "
Palm Warbler	11 "
Dark-eyed Junco	20 "
Chipping Sparrow	35 "
Lincoln's Sparrow	12 "
Total No. Territories	203 territories/100 ha
Species Richness	15
C.I.N.	11

Table 39. Bitumount muskeg plot breeding bird data (1976 and 1977).

Species	Density			
	1976		1977	
Spruce Grouse	0.28	observ./km	0.24	observ./km
Sandhill Crane	1	terr./100 ha	1	terr./100 ha
Common Snipe	3	"	3	"
Greater Yellowlegs	3	"	3	"
Great Horned Owl	PR		PR	
Common Flicker	3	"	3	"
Hairy Woodpecker	3	"	3	"
Yellow-bellied Flycatcher	7	"	3	"
Alder Flycatcher	15	"	14	"
Western Wood Pewee	3	"	PR	"
Gray Jay	6	"	3	"
Black-capped Chickadee	1	"	5	"
Boreal Chickadee	3	"	8	"
Hermit Thrush	5	"	CL	
Swainson's Thrush	19	"	8	"
Ruby-crowned Kinglet	22	"	7	"
Solitary Vireo	0	"	3	"
Red-eyed Vireo	0	"	3	"
Black-and-white Warbler	14	"	9	"
Tennessee Warbler	84	"	50	"
Orange-crowned Warbler	15	"	3	"
Magnolia Warbler	BR		PR	
Yellow-rumped Warbler	16	"	22	"
Bay-breasted Warbler	PR		0	"
Blackpoll Warbler	CL		0	"
Palm Warbler	48	"	47	"
Common Yellowthroat	7	"	8	"
Wilson's Warbler	52	"	21	"
Rose-breasted Grosbeak	CL		0	"
Purple Finch	5	"	0	"
Savannah Sparrow	PR		0	"
LeConte's Sparrow	0	"	2	"
Sharp-tailed Sparrow	3	"	0	"
Dark-eyed Junco	12	"	8	"
Chipping Sparrow	48	"	33	"
Clay-coloured Sparrow	46	"	43	"
White-throated Sparrow	55	"	55	"
Lincoln's Sparrow	50	"	46	"
Swamp Sparrow	17	"	13	"
Total No. Territories	571	"	418	"
Species Richness	30		29	
C.I.N.	N/A		N/A	

Table 40. Tamarack plot breeding bird data (1977).

Species	Density	
Sharp-tailed Grouse	1	dancing ground
Sandhill Crane	2	territories/100 ha
Common Snipe	2	"
Greater Yellowlegs	1	"
Lesser Yellowlegs	BR	
Short-billed Dowitcher	4	"
Common Flicker	CL	
Eastern Kingbird	7	"
Western Wood Pewee	15	"
Tree Swallow	2	"
Gray Jay	3	"
Yellow-rumped Warbler	5	"
Palm Warbler	5	"
Rusty Blackbird	5	"
Savannah Sparrow	18	"
Chipping Sparrow	44	"
Lincoln's Sparrow	63	"
Total No. Territories	176	territories/100 ha
Species Richness	14	
C.I.N.	10	

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Table 41. Breeding bird data from sub-plot analysis of the Bitumount aspen forest plot (1976).

Species	No Willow Subcanopy. some Alder Present. (12 ha)		Willow Subcanopy present (7.75 ha)		Subplot 3 (10 ha)	
Least Flycatcher	25	territories/100 ha	180	territories/100 ha	195	territories/100 ha
Black-capped Chickadee	2	"	6	"	13	"
Hermit Thrush	19	"	10	"	13	"
Swainson's Thrush	12	"	30	"	23	"
Red-eyed Vireo	31	"	58	"	63	"
Philadelphia Vireo	0	"	0	"	5	"
Black-and-white Warbler	13	"	0	"	15	"
Tennessee Warbler	58	"	48	"	65	"
Ovenbird	131	"	126	"	145	"
Canada Warbler	19	"	2	"	15	"
American Redstart	8	"	0	"	10	"
Rose-breasted Grosbeak	10	"	16	"	5	"
Dark-eyed Junco	0	"	6	"	5	"
Chipping Sparrow	15	"	16	"	23	"
White-throated Sparrow	2	"	0	"	0	"
Total No. Territories	345	"	498	"	595	"
Species Richness	13		11		16	

Table 42. Breeding bird data from subplot analysis of the McClelland aspen plot (1976).

Species	Tree canopy mostly dense (6.25 ha)	Tree canopy closed (13.25 ha)
Least Flycatcher	8 territories/100 ha	2 territories/100 ha
Black-capped Chickadee	12 "	0 "
Hermit Thrush	12 "	8 "
Red-eyed Vireo	28 "	13 "
Philadelphia Vireo	8 "	0 "
Black-and-white Warbler	8 "	2 "
Tennessee Warbler	100 "	28 "
Ovenbird	68 "	51 "
Dark-eyed Junco	12 "	8 "
Total No. Territories	264 territories/100 ha	117 territories/100 ha
Species Richness	10	8

Table 43. Breeding bird data from subplot analysis of the mature jack pine plot (1976).

Species	Tree canopy mostly open	Tree canopy mostly closed
Common Nighthawk	5 territories/100 ha	0 territories/100 ha
Northern Three-toed Woodpecker	2 "	2 "
Gray Jay	4 "	4 "
Boreal Chickadee	6 "	4 "
Yellow-rumped Warbler	20 "	27 "
Dark-eyed Junco	9 "	2 "
Chipping Sparrow	43 "	8 "
Total No. Territories	88 "	47 "
Species Richness	7	6

Table 44. Breeding bird data from subplot analysis of the mature mixed forest plot (1976)

Species	Over mature open forest mostly spruce or aspen		Mature (denser) forest	
Common Flicker	7	territories/100 ha	8	territories/100 ha
Pileated Woodpecker	3	"	0	"
Yellow-bellied Sapsucker	30	"	18	"
Hairy Woodpecker	4	"	0	"
Least Flycatcher	32	"	5	"
Western Wood Pewee	5	"	0	"
Gray Jay	4	"	5	"
Blue Jay	4	"	3	"
Black-capped Chickadee	4	"	0	"
Boreal Chickadee	8	"	0	"
Red-breasted Nuthatch	15	"	3	"
Winter Wren	13	"	5	"
Swainson's Thrush	50	"	46	"
Ruby-crowned Kinglet	5	"	0	"
Solitary Vireo	6	"	0	"
Red-eyed Vireo	24	"	5	"
Warbling Vireo	5	"	0	"
Balck-and-white Warbler	0	"	21	"
Tennessee Warbler	112	"	79	"
Orange-crowned Warbler	0	"	3	"
Magnolia Warbler	8	"	0	"
Cape May Warbler	10	"	0	"
Yellow-rumped Warbler	31	"	13	"
Bay-breasted Warbler	30	"	0	"
Ovenbird	7	"	33	"
Mourning Warbler	5	"	0	"
Canada Warbler	0	"	23	"
Western Tanager	23	"	15	"
Rose-breasted Grosbeak	8	"	8	"
Evening Grosbeak	2	"	0	"
Purple Finch	5	"	0	"
Pine Siskin	8	"	0	"
Dark-eyed Junco	5	"	5	"
Chipping Sparrow	67	"	54	"
White-throated Sparrow	25	"	3	"
Total No. Territories	583	territories/100 ha	354	territories/100 ha
Species Richness	33		20	

Table 45. Breeding bird data from subplot analysis of the young mixed forest plot (1977).

	Subplot 1 Understory sparse; predominantly deciduous (5.25 ha)	Subplot 2 Understory dense; older dominated (10.75 ha)	Subplot 3 Understory dense; black spruce dominated (11.75 ha)	Subplot 4 Willow bog and adjacent forest (9.0 ha)
Yellow-bellied Flycatcher	14 terr./100 ha	12 terr./100 ha	0	6 terr./100 ha
Gray Jay	10 "	5 "	15 terr./100 ha	14 "
Boreal Chickadee	0	0	0	3 "
Hermit Thrush	33 "	0	11 "	0
Swainson's Thrush	5 "	14 "	45 "	36 "
Solitary Vireo	14 "	0	9 "	0
Red-eyed Bireo	0	2 "	2 "	0
Black-and-white Warbler	5 "	9 "	30 "	28 "
Tennessee Warbler	5 "	12 "	36 "	56 "
Magnolia Warbler	0	2 "	0	11 "
Yellow-rumped Warbler	14 "	26 "	74 "	44 "
Bay-breasted Warbler	0	0	11 "	0
Ovenbird	38 "	56 "	9 "	11 "
Rose-breasted Grosbeak	0	0	4 "	0
Dark-eyed Junco	14 "	19 "	21 "	22 "
Chipping Sparrow	14 "	16 "	19 "	25 "
White-throated Sparrow	0	0	4 "	8 "
Lincoln's Sparrow	0	0	0	6 "
Total No. Territories	167 terr./100 ha	172 terr./100 ha	289 terr./100 ha	270 terr./100 ha
Species Richness	12	12	15	14

Table 46. Breeding bird data from subplot analysis of LaFont Island (1976).

Species	Willow Scrub		Mature Balsam Poplar	
Spotted Sandpiper	0	territories/100 ha	8	territories/100 ha
Common Flicker	1	"	7	"
Yellow-bellied Sapsucker	1	"	7	"
Alder Flycatcher	20	"	0	"
Least Flycatchaer	0	"	64	"
Common Raven	0	"	4	"
American Robin	6	"	10	"
Swainson's Thrush	36	"	8	"
Red-eyed Vireo	12	"	12	"
Philadelphia Vireo	6	"	34	"
Black-and-white Warbler	10	"	10	"
Tennessee Warbler	80	"	40	"
Yellow Warbler	20	"	12	"
Ovenbird	0	"	24	"
Northern Waterthrush	45	"	43	"
Mourning Warbler	0	"	20	"
American Redstart	59	"	33	"
Rose-breasted Grosbeak	11	"	17	"
Evening Grosbeak	0	"	PR	"
Clay-colored Sparrow	4	"	0	"
White-throated Sparrow	5	"	13	"
Fox Sparrow	4	"	4	"
Song Sparrow	40	"	30	"
Total No. Territories	365	territories/100 ha	425	territories/100 ha
Species Richness	17	spp.	20	spp.

Table 47. Breeding bird data from subplot analysis of the deciduous shrub fen plot (1977).

Species	Willow dominated (6.5 ha)		Swamp birch dominated (21.25 ha)	
Common Snipe	15	territories/100 ha	12	territories/100 ha
Alder Flycatcher	69	"	5	"
American Robin	4	"	1	"
Tennessee Warbler	CL		4	"
Yellow Warbler	8	"	0	"
Blackpoll Warbler	4	"	0	"
Palm Warbler	0	"	5	"
Common Yellowthroat	99	"	72	"
Wilson's Warbler	69	"	8	"
American Redstart	BR		0	"
LeConte's Sparrow	0	"	21	"
Chipping Sparrow	CL		CL	
Clay-colored Sparrow	61	"	81	"
White-throated Sparrow	6	"	4	"
Lincoln's Sparrow	11	"	42	"
Swamp Sparrow	237	"	52	"
Total No. Territories	583	territories/100 ha	307	territories/100 ha
Species Richness	11	species	12	species

Table 48. Breeding bird data from subplot analysis of the tamarack muskeg plot (1977).

Species	Bog birch 1.5 m tall	
Short-billed Dowitcher	5	territories/100 ha
Western Wood Pewee	40	"
Tree Swallow	5	"
Yellow-rumped Warbler	20	"
Savannah Sparrow	15	"
Chipping Sparrow	45	"
Lincoln's Sparrow	65	"
Total Territories/100 ha	195	"
Species Richness	7	

Table 49. Breeding Bird Data from Subplot Analysis of the Young Black Spruce Plot (1977).

Bird Species	Pure black spruce less than 5 m (9.5 ha)	Some pine and aspen in the tree stratum (4.75 ha)	Shrublayer at least 10% deciduous (14.75 ha)	100% black spruce open above 2 m (3.75 ha)	100% black spruce mostly dense above 2 m (7.75 ha)	Black spruce predominantly less than 3 m in height and open (3.5 ha)	Open black spruce bitumount muskeg plot 1977 (3.5 ha)
Yellow-bellied Flycatcher	13 t/ha	5 t/ha	3 t/ha	27 t/ha	6 t/ha	0 t/ha	0 t/ha
Gray Jay	13	11	10	20	10	7	7
Boreal Chickadee	8	5	5	7	6	0	7
Hermit Thrush	0	0	2	0	0	0	0
Swainson's Thrush	13	16	20	13	16	14	7
Ruby-crowned Kinglet	13	11	7	20	13	0	0
Solitary Vireo	0	0	2	0	0	0	0
Black-and-white Warbler	0	5	5	0	3	0	7
Tennessee Warbler	3	16	7	0	3	0	0
Yellow-rumped Warbler	5	26	25	7	10	7	14
Blackpoll Warbler	0	0	2	0	0	0	0
Palm Warbler	74	26	61	100	55	93	179
Dark-eyed Junco	33	11	15	40	48	14	14
Chipping Sparrow	15	16	15	20	13	21	50
White-throataed Sparrow	10	26	32	0	23	29	36
Lincoln's Sparrow	0	0	10	0	0	0	7
Total Territories/100 ha	200	174	222	253	206	186	329
Species Richness	11 spp.	12 spp.	16 spp.	9 spp.	12 spp.	7 spp.	10 spp.
Density of all species except Palm Warblers	126	148	161	153	151	93	150

Table 50. Breeding bird data from subplot analysis at the Bitumount muskeg plot (1976 and 1977).

Species	Black spruce mostly open and 4 to 8 m tall (3.5 ha)		Mature tamarack/ fen (3.0 ha)		Scrub willow (4.75) ha		Tall willow with scattered trees (11.5 ha)		Bitumount muskeg plot (30.0 ha)	
	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977
Sandhill Crane	0 t/ha	0 t/ha	8 t/ha	8 t/ha	0 t/ha	0 t/ha	0 t/ha	0 t/ha	1 t/ha	1 t/ha
Common Snipe	0	7	8	8	5	0	2	2	3	3
Greater Yellowlegs	0	0	8	8	0	0	2	2	3	3
Common Flicker	0	0	0	0	0	5	2	7	3	3
Hairy Woodpecker	0	0	0	0	0	0	2	2	3	3
Yellow-bellied Flycatcher	0	0	8	0	0	0	7	7	7	3
Alder Flycatcher	0	0	8	0	26	16	22	15	5	14
Western Wood Pewee	0	0	8	0	0	0	0	0	3	
Gray Jay	7	7	17	0	5	5	7	7	6	3
Black-capped Chickadee	0	0	0	0	0	5	0	11	1	5
Boreal Chickadee	0	7	0	0	0	0	2	13	3	8
Hermit Thrush	7	0	0	0	0	0	2	0	5	0
Swainson's Thrush	14	7	17	0	11	5	20	13	9	8
Ruby-crowned Kinglet	0	0	8	0	5	0	22	9	22	7
Solitary Vireo	0	0	0	0	0	5	0	7	0	3
Red-eyed Vireo	0	0	0	0	0	0	0	4	0	3
Black-and-white Warbler	7	7	0	0	5	5	20	22	14	9
Tennessee Warbler	21	0	33	8	95	47	124	89	84	50
Orange-crowned Warbler	29	0	0	0	32	0	17	4	15	3
Yellow-rumped Warbler	29	14	8	17	5	5	15	20	16	22
Palm Warbler	171	179	25	8	21	5	22	26	48	47
Common Yellowthroat	9	9	8	8	16	16	7	4	7	8
Wilson's Warbler	14	0	0	0	132	37	61	41	52	21
Purple Finch	0	0	33	0	0	0	0	0	5	0
LeConte's Sparrow	0	0	0	8	0	0	0	0	0	2
Sharp-tailed Sparrow	0	0	33	0	0	0	0	0	3	0
Dark-eyed Junco	29	14	8	0	0	0	2	4	12	8
Chipping Sparrow	71	50	67	17	47	0	33	26	48	33
Clay-colored Sparrow	0	0	0	0	205	132	59	54	46	43
White-throated Sparrow	64	36	0	17	68	79	78	76	55	55
Lincoln"s Sparrow	43	7	83	125	68	89	37	26	50	46
Swamp Sparrow	0	0	125	83	0	5	0	0	17	13
Total No. Territories	507	336	517	308	147	463	563	491	561	418
Species Richness	t/ha 13	t/ha	t/ha 20	t/ha 12	t/ha 16	t/ha 16	t/ha 23	t/ha 26	t/ha 30	t/ha 299

7.3 HABITAT DESCRIPTIONS OF THE STUDY PLOTS

7.3.1 Bitumount Aspen Forest Plot

Figure 27 illustrates a cross-section of this plot. The aspen forest study plot represented an almost pure and uniform stand of aspen (*Populus tremuloides*) which formed a dense to closed canopy over most of the plot. The height of aspen varied with topogaphy but averaged 15 m. The spacing of individual aspens was similar over most of the plot, except for the southeast corner where trunk density was greater.

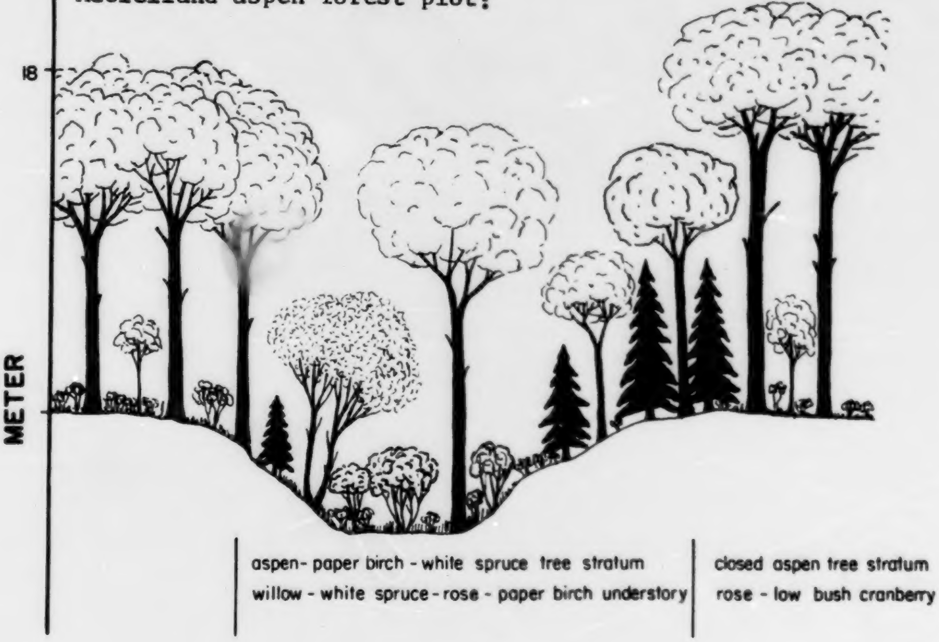
Other species in Stratum 3 represented 30% or less of total canopy and were generally shorter than the aspen. Paper birch (*Beulta papyrifera*), which was present on most blocks, averaged 10 m in height although there was, as with aspen, a variation with topography.

Willow (*Salix* spp.) ranged from 6 to 9 m in Stratum 3 and in most blocks was less dense than the other tree species. The highest densities of willow occured in the southern and western blocks.

The dominant species of the dense Stratum 2 were low-bush cranberry (*Viburnum edule*), alder (*Alnus crispa*), rose (*Rosa* spp.) and paper birch, together forming a dense canopy which ranged from 1 to 3 m in height.

Forbs constituted the largest percentage of stratum vegetation. Bunchberry (*Cornus canadensis*), strawberry (*Fragaria* spp.), sarsaparilla (*Aralia nudicaulis*), twin-flower (*Linnaea borealis*) and wintergreen (*Pyrola* spp.) were the most common species. Shrubs, predominantly rose and low-bush cranberry, were the second most common plant form in this stratum and formed about 30% of the canopy. The relative abundance of grasses varied widely among sampled blocks, but overall its occurrence within the plot was low.

The topography of the plot had a significant effect on the composition and form of the vegetation. The study plot was dissected by several ravines whose slopes and bottoms had different vegetation patterns than the upland blocks. Aspen in


McClelland aspen forest plot:
18
METER
aspen- paper birch - white spruce tree stratum
willow - white spruce - rose - paper birch understory
closed aspen tree stratum
rose - low bush cranberry

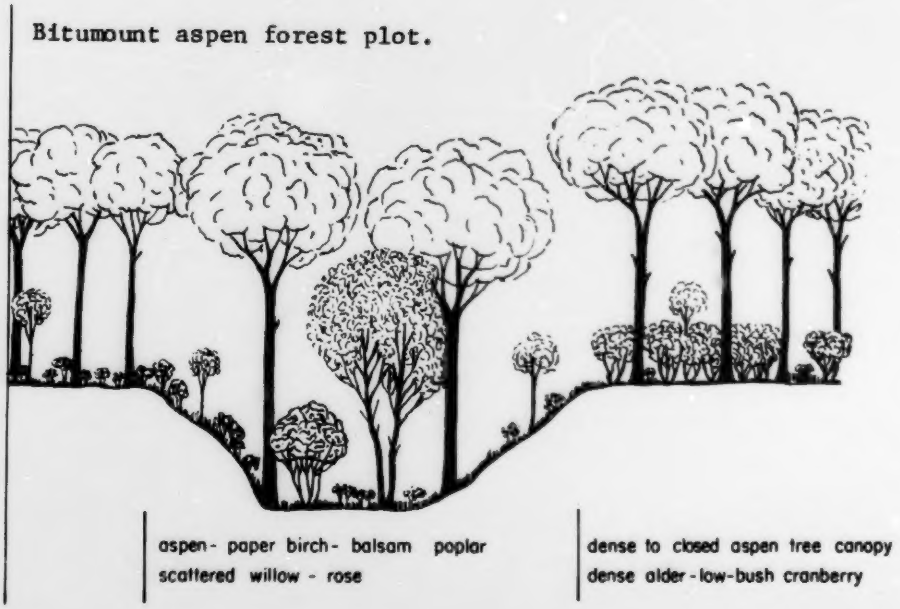

Bitumount aspen forest plot.
aspen - paper birch - balsam poplar
scattered willow - rose
dense to closed aspen tree canopy
dense alder - low-bush cranberry

Figure 27. Cross-sections of the Bitumount and McClelland aspen forest plots.

the ravine bottoms was more widely spaced and taller, often reaching heights of 19 m. Paper birch was more dense and taller in the ravines than on the upland blocks. Balsam poplar (*Populus balsamifera*), which only occurred in the ravines, was of a similar height to aspen but occurred at much lower densities. Stratum 2 of the ravines decreased in density from the top to bottom of the ravines, while, in Stratum 1, forbs, and occassionally grasses, increased in density. Horsetail (*Equisetum* spp.) was present in the ravines at higher densities than on the upland blocks.

Mosses and lichens were sparse throughout the study plot. Litter was abundant and comprised deciduous leaves and branches. Fallen trees and standing dead trees were common on most of the sampled blocks.

The overall soil texture of the plot was loamy-sand while the ravine bottoms were a sandy-loam. The soil was generally well drained except for a small meadow, covered by sedges (*Carex* spp.), and reed grass (*Calamogrositis* spp.), which may have held water for short periods of time in the spring.

7.3.2 McClelland Lake Aspen Plot

This study plot was dominated by mature aspen with white spruce and paper birch forming smaller proportions of the canopy. Figure 27 is an illustration of a typical cross-section through this plot. For most blocks, 70% or more of the closed or dense Stratum 3 canopy was formed by aspen averaging 18 m in height. The presence of white spruce, which ranged from 8 to 20 m in height, was most noticeable along the ravines. On some blocks white spruce formed up to 45% of the tree canopy but the overall percentage for the plot was estimated to be less than 10%. Paper birch was scattered throughout the plot but it was most common in the ravines where it occasionally dominated Stratum 3.

Stratum 2 was seldom over 1 m tall and was dominated by rose and low bush cranberry. Willow, paper birch, aspen, and white spruce were occasional components of this stratum. Their occurrence was largely restricted to ravines where, singly or in combination, they formed a canopy 3 to 4 m in height and of varying density.

The understory canopy was seldom over 1 m tall and was dominated by low bush cranberry and rose. When willow, paper birch, aspen, or white spruce occurred in the understory stratum it was usually in the ravines and here a canopy 3 to 4 m in height and of varying density was formed.

Forbs were the dominant plant form in Stratum 1 and comprised bunchberry, strawberry, twin-flower, and wintergreen. The ratio of shrubs to forbs in this stratum was highly variable from block to block. Blueberry (*Viburnum myrtilloides*), low bush cranberry, and rose were the most common shrubs. Grasses and horsetail always formed a low percentage of the stratum.

The detritus layer of the forest floor was thick and comprised deciduous leaves, forbs, and fallen branches. Fallen trees and standing dead aspen, averaging 7 m in height, were present on most blocks. Standing dead paper birch and willow occurred at low percentages in the ravines.

An inter-connecting system of steep-sided ravines drained to the north towards McClelland Lake. Three depressions of substantial size were present and had developed wet meadow vegetation communities because of poor drainage. The soil for most of the plot was sand which was well drained.

7.3.3 Aspen-Pine Plot

The plot of mixed aspen-jack pine forest located on the south-facing escarpment of the Fort Hills was 43 ha in size. Within this area, two hundred 50 m x 50 m blocks were described. Table 51 lists the percentage breakdown of the forest cover types described for the blocks of this plot.

The height of the aspen ranged from 6 to 15 m, with the average being 11 m. The distribution of aspen created a dense to closed canopy on the majority of the aspen-dominated blocks (Figure 28).

Table 51. Percentages of habitat types for blocks described on the Aspen-Pine plot.

Habitat Type	Percentage of all blocks described
Aspen forest	44.6
Jack pine forest	21.9
Aspen-pine forest	15.0
Pine-aspen forest	5.5
Aspen-pine-spruce forest	4.8
Pine-aspen-spruce forest	3.4
Aspen-spruce forest	2.7
Spruce-aspen forest	0.7
Black spruce muskeg	0.7
Shrub upland	0.7

Figure 28. Plant species distribution on the mature pine-dominated section of the aspen-pine forest.

There were two age classes of jack pine present on this plot. Jack pine, greater than 15 m in height, formed a stand that was relatively open while the younger jack pine formed dense to closed canopies 9 m tall. This latter forest type was restricted to the northeastern corner of the plot while the older jack pine was dominant over the southern half of the plot.

White spruce, which averaged 11 m in height, was present on only a few blocks and usually formed scattered canopy under the mature jack pine.

The southeast corner of the plot included an area of black spruce muskeg dominated by 12 m tall black spruce.

Table 52 lists age and height data of trees sampled on this plot.

Stratum 2 was also variable with the dominant shrub species being alder. The alder canopy was dense to closed under the more open stands of jack pine and aspen but was sparse under the dense stands of aspen. Under these dense stands of aspen the shrub layer comprised low bush cranberry, rose, snowberry (*Sympharicarpos albus*), and Saskatoon berry (*Amelanchier alnifolia*). Aspen 1 to 4 m in height was a minor component of Stratum 2 in most blocks.

The presence and height of white spruce in the understory canopy were variable.

Bearberry, blueberry, bog cranberry, and rose dominated Stratum 1 and in general these dwarf shrubs formed 60% or more of the ground stratum cover. Forbs, dominated by bunchberry, fireweeds (*Epilobium angustifolium*), twin-flower, and strawberry, were more variable and usually formed 20% or less of Stratum 1 cover. Grasses were scattered or absent for most blocks. Club-mosses (*Lycopodiaceae* spp.) were more common under the jack pine forests but rarely formed more than 5% of the stratum cover. Stratum 1 was predominantly shrub in composition under jack pine and aspen canopies but the forb density was greater under the aspen canopies.

Table 52. Ages and heights of trees sampled on the aspen-pine breeding bird plot.

Species	N	Age $\bar{X}$ (years)	Height $\bar{X}$ (metres-visually estimated)
Aspen	8	35	11.8
Pine[a]	7	103	18.6
Pine[b]	4	26	10.5
White Spruce	1	58	18

[a] Pine sampled in the mature section of forest

[b] Pine sampled in the immature section of forest

Lichens, which were restricted to the more open areas of jack pine, and mosses, which were more common, were variable over the entire plot.

Standing dead trees were scarce but large fallen jack pine were common on many of the blocks. Leaf litter was dense under the aspen forest.

This forest was situated on a well-drained soil which comprised a thin top layer of loamy sand underlaid by pure sand. The entire plot had a slight south-facing slope with two small ravines being the only major topographic relief within the plot.

7.3.4 Mature Jack Pine Plot

Stratum 3 of this plot consisted entirely of mature jack pine with a mean height of 12 m. The canopy density for most of the blocks was dense or closed although there were some blocks in the southern and western portions of the plot with scattered or open canopies. Some of the blocks had been burned over some time in the past, which resulted in the establishment of small areas with closed canopies of young jack pine 6 m tall.

Forty-nine of the 112 blocks sampled were classified as having no Stratum 2 and the remaining blocks usually had a scattered understory canopy. The only blocks with a substantial Stratum 2 were the blocks with a history of fire and on these 1 to 2 m jack pine was common. Individual plants of spreading dogbane (*Apocynum androsaemifolium*), aspen, rose, and jack pine were widely scattered over the rest of the plot.

Stratum 1 was composed almost totally of dwarf shrubs which generally had a scattered distribution. Common bearberry, blueberry (*Vacinnium myrtilloides*), bog cranberry (*Vaccinium vitis-idaea*), spreading dogbane, and jack pine were all present in the shrub component. Forbs and grasses always occurred in low densities, usually averaging 5% of the Stratum 1 canopy.

Coniferous needles and small branches formed a thin layer of detritus over the dry sandy soil. Fallen trees were sparse over the plot although on a few blocks fallen trees were common. Fifty-four of the sampled blocks contained standing dead trees. Lichen, either with a dense or sparse distribution, was more common than moss.

7.3.5 Young Jack Pine Plot

This "scrub" jack pine forest is the result of a fire that destroyed the former forest of mature jack pine. This second-growth forest was dominated by young, densely packed jack pine which was seldom over 6 m tall. There were scattered older pines which had survived the fire and were now 12 m in height. In the six blocks where these mature pines occurred, the understory comprised young jack pines or, when the understory was absent, a lichen floor was characteristic. Aspen and paper birch, forming a scattered to dense canopy 7 m tall, were present in small percentages along shallow ravines that traversed the plot. Throughout the plot, the foliage profile was essentially dense and continuous from 2 m up. In blocks where the jack pine reached heights of 8 m, the understory jack pine was scattered. The understory of the ravines comprised jack pine, alder, aspen, and paper birch.

Common bearberry, bog cranberry, blueberry, and jack pine formed most of the Stratum 1 canopy. Forbs were very sparse.

A thin uneven layer of coniferous needles covered parts of the forest floor but bare areas of sand were common. Throughout the plot there was an abundance of large, charred, fallen trees. There were also scattered, standing, dead trees which reached heights of 12 m. Lichens and mosses were sparse overall although dense patches of lichen occurred under open canopies. The topography of the study plot was generally flat except for a few knolls and shallow ravines.

7.3.6 Mature Mixed Forest Plot

Both composition and form of the tree canopy of this plot were amorphous. Heights, distribution and densities of individual tree species varied greatly between adjacent blocks. White spruce

(*Picea glauca*), jack pine (*Pinus banksiana*), paper birch, aspen, and balsam poplar were all present in the tree stratum. This forest was overmature and many of the older trees had fallen and thus created clearings in which young stands of various species had become established. White spruce was the tallest species on the plot with some trees reaching heights of 30 m or more. The heights of most species were usually between 7 and 15 m although some individuals were considerably taller. Table 53 contains the percentage breakdown of the various forest cover types of the sampled blocks.

Stratum 2 comprised several species of shrubs which formed a dense canopy averaging 1.5 m in height.

Stratum 1 was dominated by forbs and shrubs, with grasses forming scattered canopies in many of the blocks.

Mosses, lichen, deciduous leaves and fallen branches and trees were common on the forest floor. Standing dead trees were found on all but two of the sampled blocks with standing dead aspen, ranging in height from 5 to 11 m, being the most common.

The soil was a loamy-sand texture and was well drained. The topography of the plot was variable, with knolls and depressions being most common and to a lesser extent steep-sided ravines. Two of the depressions held water for short periods of time and as a result had developed wet meadow vegetation.

7.3.7 Young Mixed Forest Plot

The young mixed forest plot, 37 ha in size, was situated about 8 km west of the south end of Kearl Lake. Located in an area which was swept by forest fire some time between 1935 and 1940, the stand was fairly uniform in size and age. All the dead spars which were still identifiable were jack pine, as were the few trees that survived. It appears that the previous forest was a jack pine stand about 20 m in height and about 135 years old.

Table 53. Percentage of habitat types for blocks described on the mature mixed forest plot.

Forest Cover Type	Percentage of Total Blocks Sampled
Aspen-spruce forest	35
Spruce-aspen forest	30
Aspen-pine-spruce forest	10
Pine-aspen-spruce forest	10
Birch forest	5
Aspen-birch forest	5
Aspen forest	2.5
Pine-aspen forest	2.5

The general habitat type was pine-aspen-black spruce forest. The tree canopy varied between 5 and 14 m in height and was in the range of 9 to 12 m in about 80% of the blocks. Tree canopy density varied from open to closed, but was generally dense. Jack pine was the dominant tree species, constituting an average of 55% (range 5 to 90%) of the canopy. Trembling aspen formed an average of 35% (range 5 to 90%) of the canopy, while black spruce averaged 10% (range 0 to 70%) and was absent from about 20% of the blocks. Aspen trees were generally 1 to 2 m taller than jack pines. The black spruce was generally 5 to 7 m tall, forming a scattered layer beneath the pine and aspen. Table 54 gives a cross-section of the stand age.

The plot contained a narrow band of willow bog which ran from the southeast corner to the middle of the north side. The bog varied between 20 and 80 m in width and was devoid of tree canopy.

Stratum 2 varied between scattered and closed, but was dense over most of the plot. One area of about 5 ha had a scattered to open understory. Stratum 2 had three main components: alder, black spruce, and willow. Swamp birch, jack pine, and trembling aspen were fairly common, and low bush cranberry, Saskatoonberry, white birch, and tamarack were occasionally present in small amounts. Black spruce, varying from 1 to 4.5 m in height, dominated the understory over approximately half the plot. When dominant, it was usually open to dense or else in scattered impenetrable copses. Over the rest of the plot it was scattered to open, and occasionally absent. Alder dominated the understory over approximately one third of the plot. When present, it formed generally dense cover about 1.5 to 2 m in height. Alder was absent from many blocks and was generally dominant when present. Willow was ubiquitous on this plot. Uniformly 1.5 to 3 m tall, it was dense in the willow bog areas, but scattered or occasionally open in the forest. Willow dominated the forest understory in only a few blocks. In these instances it did so not because of its own abundance, but rather because of the near absence of spruce and alder. Jack pine and aspen were frequent minor components of the understory: varying between 2 and 4.5 m

Table 54. Age of trees on the young mixed forest plot, 1977.

Species	Height (metres)	Age
Jack pine	10	33
Jack pine	8	30
Jack pine	3	23
Jack pine	8	33
Jack pine	14	30
Jack pine	20	170
Trembling aspen	4	23
Trembling aspen	12	35
Trembling aspen	6	36
Trembling aspen	17	42
Black spruce	5	28
Black spruce	2	28

in height, they generally constituted 10% or less of the total Stratum 2. Swamp birch was a major component in the willow bog portion of the plot where it formed an open layer 1 m in height beneath the 2 to 3 m willow. Swamp birch was rarely present in the forest portion of the plot.

7.3.8 Athabasca River Transect Plot

This transect paralleled the Athabasca River and crossed through several different cover types. Topographically, it divided neatly into two halves: a bottomland floodplain which was characterized by overmature balsam poplar forest and willow scrub; and the valley slopes which supported a variety of aspen-spruce-birch mixed forest types. For analytical purposes, the transect was divided into these two sections; they have been treated as two separate strip plots.

The bottomland strip plot, which was 1400 m long and about 200 m wide, was topographically flat except for a small depression which ran along the interface between the balsam poplar forest and the willow scrub (Figure 29). The soil was moist and well drained, except the depression, which flooded to a depth of several centimetres when water levels in the Athabasca River were high. The river bank was vertical and eroding, varying in height from 0.5 to 3 m, depending on the water level.

Three distinct habitat types were present in this strip plot. The oldest habitat was an overmature balsam poplar forest, in which many of the trees were at least 170 years old. Trunk sizes were massive, some of the trees had fallen, and many had lost their crowns. Although well spaced, the trees formed a generally dense canopy up to and over 25 m high. A few white spruce trees, equivalent in height to the balsam poplar, were scattered through the stand. A scattered to open subcanopy of 0.5 to 20 m tall aspen and 0.5 to 8 m tall river alder was present below the balsam poplar in most blocks; thus at least a scattered layer of foliage was present at all heights in the tree stratum.

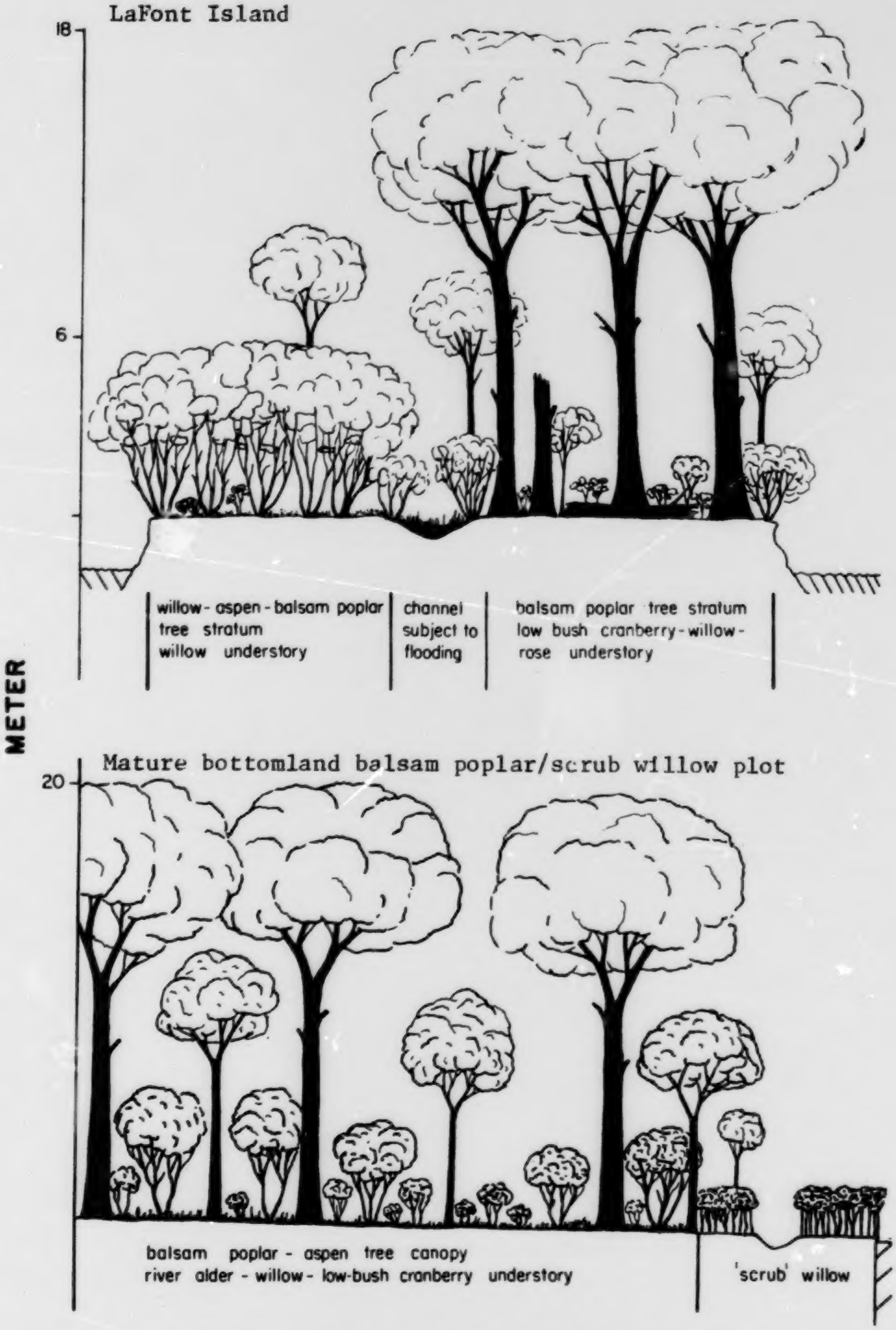

LaFont Island
18
6
METER
willow - aspen - balsam poplar tree stratum willow understory
channel subject to flooding
balsam poplar tree stratum low bush cranberry - willow - rose understory
Mature bottomland balsam poplar/scrub willow plot
20
balsam poplar - aspen tree canopy river alder - willow - low-bush cranberry understory
'scrub' willow

Figure 29. Cross-sections of LaFont Island and the mature bottomland balsam poplar/scrub willow plot.

Stratum 2 formed a dense to closed canopy which ranged from 0.5 to 4 m in height and comprised alder, dogwood (*Cornus stolonifera*), low-bush cranberry, white spruce, and raspberry (*Rubus* spp.).

Stratum 1 of most blocks was dominated by horsetail and various shrubs. Horsetail was present in all blocks and in some blocks it formed 90% of Stratum 1 vegetation. Shrubs were the second most common plant form in this stratum. Usually shrubs formed a scattered canopy comprising raspberry, dogwood, and low bush cranberry. The presence of forbs and grasses was variable. Forbs averaged 5% of the Stratum 1 canopy while grasses were present in significant densities only on a few blocks. Lichens and mosses were scarce along this section of the transect.

Deciduous leaves were dense over most of the forest floor but areas of bare soil did occur. Fallen branches and trees and standing dead trees, mostly balsam poplar with heights ranging from 10 to 17 m, were common.

Between the balsam poplar forest and the river was a band of willow scrub about 100 m wide. The willow formed a closed canopy 2.5 m tall. The ground cover in the willow scrub was scattered to open and consisted of forbs and grasses. The interface between the willow scrub and the overmature balsam poplar was quite sharp for about half the length of the strip plot.

The third habitat was an ecotone between the balsam poplar forest and the willow scrub. It formed a band about 50 m wide over about half the length of the strip plot. This ecotonal area was characterized by an open to scattered tree canopy of 5 to 9 m tall balsam poplar with a few 5 to 7 m tall willows. The shrublayer in this section was open and consisted of 2.5 to 5 m tall willows.

The river valley mixed forest strip plot was 2.75 km long and varied between 60 and 175 m in width. The transect followed the top of the river valley slope; the slope within the plot was generally between 5° and 15°, although a few sections were somewhat steeper. A sparsely vegetated bank with a 45° to 70° slope, varying between 3 and 12 m in height,was present at the north end. The water regime in this strip plot varied from moist to saturated, but moist, fairly well drained soil predominated.

Stratum 1 on this strip plot varied from block to block. Table 55 contains a percentage breakdown of the different forest cover types.

Tree heights were variable with the maximum of 25 m occurring in a mature white spruce forest. White spruce and aspen, which ranged in height from 9 to 25 m, were found on almost every block. Alder taller than 5 m was more common on this section of the transect than it was in the balsam poplar forest.

7.3.9 LaFont Island Plot

LaFont Island, an island 50 ha in size on the Athabasca River opposite the abandoned Bitumount oil sands plant, had two forest cover types. One half of the island was vegetated by a dense stand of willow while the other was vegetated by a mature balsam poplar forest. Figure 29 is an illustration of a typical cross-section of LaFont Island. The balsam poplar reached heights of 22 m and formed a dense to closed canopy. Two small copses of white spruce occurred on the island. This forest was past its prime and consequently there were many fallen trees on this section of the island.

Under the balsam poplar forest, Stratum 2 comprised dogwood, low bush cranberry and willow. The willow was largely restricted to the edge of the island, along the interface between the balsam poplar forest and willow scrub and in small clearings in the forest. The other two shrubs formed a scattered canopy in the forest interior.

On the willow scrub half of the island willow 4 to 7 m in height formed a dense to closed canopy. River alder, balsam poplar, and aspen, generally 6 to 10 m tall, were present in some areas.

Table 55. Percentage of habitat types for blocks described on the northern end of the river transect.

Habitat type	Percentage of all blocks
Aspen-spruce forest	37
Aspen forest	29
Spruce-aspen forest	14
Spruce forest	10
Shrub upland	6
Aspen forest/shrub upland	2
Spruce forest/grass-forb meadow	2

Two low-lying areas, which were subject to flooding during high water levels on the Athabasca River, had dense growths of horsetail and less dense growths of sedge. These areas, when flooded, had up to 0.5 m of water. A channel along the balsam poplar-willow interface was also subject to periodic flooding. The remaining portions of the island were well drained and had soils of a silty sand texture. The detritus layer was sparse on both sections of the island and as a result bare soil was common. Standing dead willows were common in some areas.

7.3.10 Tall Bottomland Willow Plot

Figure 30 illustrates a typical cross-section of this plot. Figure 24 illustrates the foliage height diversity which was typical of many sections of this plot. This plot, 28 ha in size, was dominated by tall willow growing alongside a section of the Muskeg River. This section of the Muskeg River was characterized by a meandering river bed and an abundance of oxbows. A stand of dense willow averaging 6 m in height occupied an area on either side of the river and this area in turn was bounded on either side by zones of shorter willow averaging 3 m in height. The plot was situated almost entirely in the taller willow. Willow in Stratum 3 averaged 6 m in height and formed a dense to closed canopy. The foliage of the willows was densest in the top 3 or 4 m and foliage in the lower section of the tree was either sparse or absent. The willow along the oxbows and river were usually shorter and formed a dense wall of foliage.

The presence of balsam poplar, which averaged 14.5 m in height, and aspen, which averaged 11.6 m in height, was restricted to five small areas. The canopy formed by these two species, either individually or together, was usually dense. Willow taller than 5 m was often present under these dense canopies.

Stratum 2 was dominated by willow which averaged 3 m in height and usually formed an open to scattered canopy under the taller willow. Dogwood and rose were also present but at much lower densities.

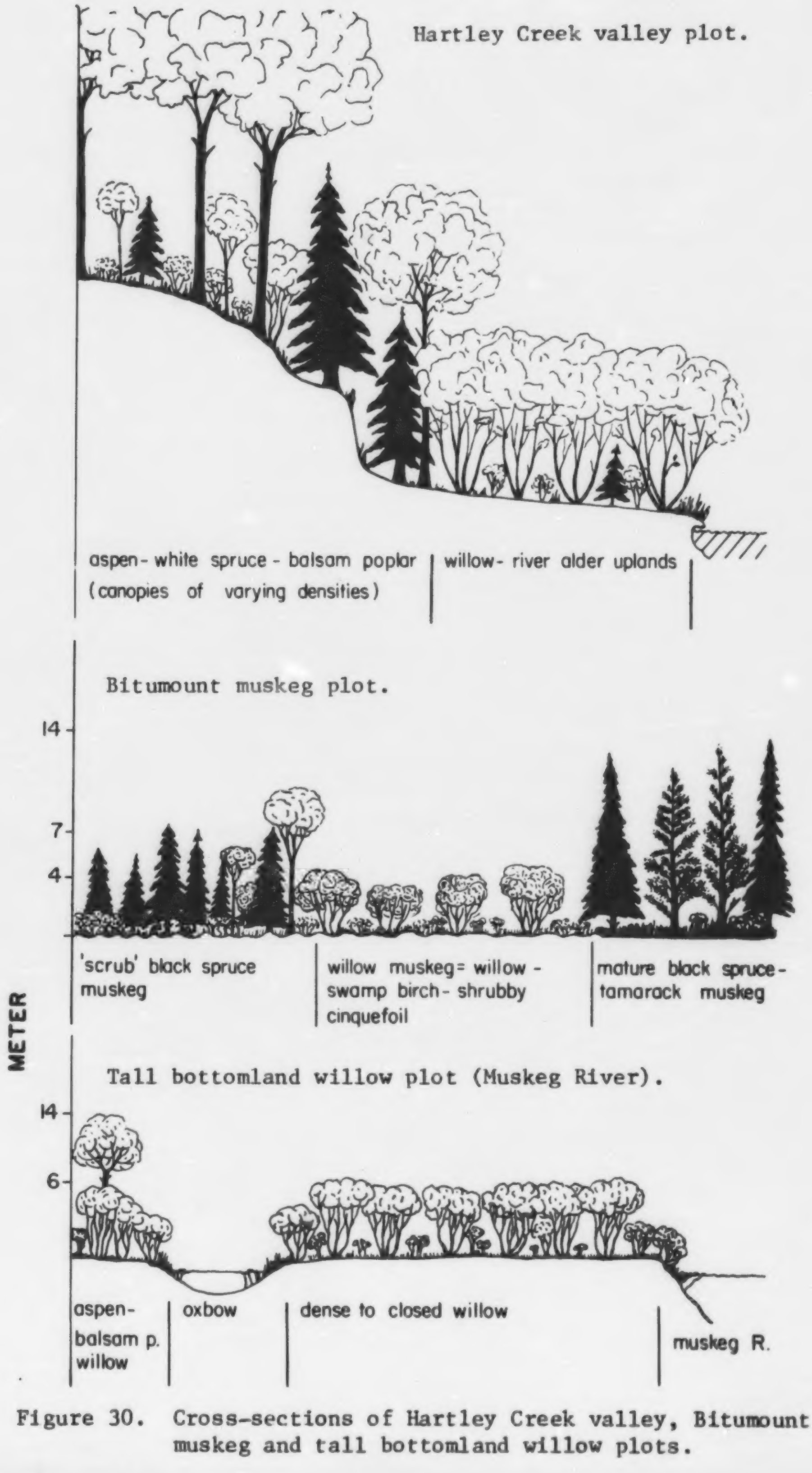

Hartley Creek valley plot.
aspen - white spruce - balsam poplar (canopies of varying densities)
willow - river alder uplands
Bitumount muskeg plot.
14
7
4
'scrub' black spruce muskeg
willow muskeg= willow - swamp birch - shrubby cinquefoil
mature black spruce - tamarack muskeg
METER
Tall bottomland willow plot (Muskeg River).
14
6
aspen-balsam p. willow
oxbow
dense to closed willow
muskeg R.

Figure 30. Cross-sections of Hartley Creek valley, Bitumount muskeg and tall bottomland willow plots.

Stratum 1 was variable with some blocks having a scattered cover which was dominated by grasses, sedges, and horsetail while other blocks had dense covers of shrubs and forbs. Shrub species included willow, rose and dogwood. Forb species were usually scattered and included strawberry, wintergreen, palmate-leaved coltsfoot (*Petasites palmatus*), fireweed, and legume species.

Some of the oxbows had emergent vegetation while others only supported a small band of sedge around the shoreline. The emergent vegetation comprised arrowhead (*Sagittaria cuneata*), bur-reed (*Sparganium* spp.), marsh marigold (*Caltha natans*), mana grass (*Glyceria* spp.) and sedges.

Mosses were sparse to absent over the forest floor while deciduous leaves were dense. The density of standing dead trees and shrubs was variable.

7.3.11 Hartley Creek Plot

Figure 30 illustrates a typical cross-section of Hartley Creek valley and Figure 31 illustrates the narrow, often shallow nature of the Hartley Creek within the plot. This 16 ha plot comprised several different habitats and a percentage breakdown of the habitat types assigned to the blocks for which a habitat description was done is listed in Table 56.

The shrub uplands were found from the creek bank back to the slope of the creek valley. This area was dominated by willow and river alder (*Alnus tenufolia*) which together formed a dense to closed canopy, averaging 6 m in height. The densities of individual species varied from block to block. The foliage profile of the mature shrub uplands was characterized by a dense layer of foliage near the top, followed by a layer of decreasing foliage density for 2 or 3 m, while the 2 to 3 m closest to the ground were devoid of foliage. Stratum 1 under this canopy was variable but usually consisted of scattered forbs and grasses.

The habitat of the slopes and uplands of the creek valley was amorphous. Several tree species were present and data for the ages and heights of these trees are presented in Table 57.

Figure 31. Hartley Creek, 1977.

Table 56. Percentages of habitat types for blocks described on the Hartley Creek Plot.

Habitat Type	Percentage of all Blocks described
Aspen forest	31.6
Shrub upland	18.5
White spruce forest	18.5
Shrub upland-mixed forest	15.7
Balsam poplar forest	7.9
Balsam poplar-aspen forest	2.6
White spruce-aspen forest	2.6
Shrub upland-white spruce forest	2.6

Table 57. Ages and heights of tree species sampled on the Hartley Creek breeding bird plot.

Species	N	Age $\overline{X}$ (Years)	Height $\overline{X}$ (metres-visually estimated)
Aspen	8	35.25	15.8
Balsam poplar	3	24.33	12.3
White spruce	4	31.5	13.8
Black spruce	2	26.0	13.0

Pure stands of aspen were not extensive but this species was found at varying densities throughout the plot. The pure stands of mature aspen formed closed canopies. The average height of aspen on the plot was 13.0 m. Stratum 2 in these stands was scattered and there was a good growth of forbs and shrubs in Stratum 1.

Although balsam poplar was not present in pure stands, it occurred at varying densities throughout the plot and was most common along the slopes of the creek valley. This species averaged 9.0 m in height.

White spruce, the most common conifer on the plot, had an average height of 10.0 m. This species was most commonly found along the slopes and floor of the creek valley.

Black spruce, an uncommon species on the plot,occurred when the muskegs present on the uplands intruded into the plot area.

The surveyed line of the plot roughly followed the valley edge. The degree of slope of the valley sides ranged from almost perpendicular to a gradual incline down to the water edge.

The soil texture of the area was variable with soils ranging from dry and sandy to wet and organic. Seepage areas, caused by drainage from upland muskegs, occurred at different locations on the plot.

7.3.12 Interface Plot

This 37.5 ha plot had several different habitats within its boundary. Table 58 contains a percentage breakdown of the various habitats described for the blocks on this plot.

The distribution of these cover types was directly related to the topography of the plot. The aspen and mixed forests were found on low ridges while the muskeg habitats were found in the low lying areas between the ridges. This abundance of interface situations characterized this plot (Figure 32).

In the aspen-dominated cover, aspen averaged 11 m in height. It was also scattered throughout other cover types. Black spruce was also present throughout the plot and ranged from 5 to 15 m in height.

Table 58. Percentages of habitat types for blocks described on the interface plot.

Forest Cover Type	Percentage of Total Blocks Sampled
Aspen-spruce forest	36
Deciduous shrub muskeg	34
Aspen forest	13
Swamp birch muskeg	9
Black spruce muskeg	7
Aspen-spruce-pine	1

7.3.13 Deciduous Shrub Fen Plot

This 30 ha plot was chosen for the presence of two cover types, a willow-dominated area of 6.5 ha and a swamp birch fen area of 21.25 ha. There were 2.25 ha of black spruce scattered over the plot. The absence of Stratum 3 was characteristic for the willow and swamp birch fen areas (Figure 33).

Stratum 2 of the willow-dominated area was characterized by a closed canopy averaging 2.5 m. Also present at much lower densities was swamp birch which formed an open canopy and averaged 1 m in height.

Stratum 1 was almost completely dominated by sedges which formed a closed canopy. Shrubs and forbs, if present at all in this stratum, were scattered.

Stratum 2 of the swamp birch fen area was dominated by swamp birch which averaged 1 m in height and usually formed a dense to open canopy. Willow was present at low densities and formed a scattered canopy in a few blocks of this section.

Sedges dominated Stratum 1 and formed a closed canopy while shrubs and forbs were scattered. Small areas completely dominated by sedges and surrounded by swamp birch were common on this plot.

Mosses, which were present over the entire plot, were densest in the area dominated by willow, although they were sparse to common in the area dominated by swamp birch and sedges. The soil for the entire plot was organic and water saturated.

7.3.14 Open Bog Plot

This 16 ha plot was situated in an area dominated by 0.75 m tall swamp birch. No tree canopy was present. The plot was bounded on one side by an area of black spruce muskeg which was dominated by trees averaging 8 m in height and on the other side by a tamarack muskeg (Figure 34). Figure 35 illustrates the vegetation zones of the plot.

Figure 32. The abundance of interface situations characteristic of the interface plot.

Figure 33. The absence of Stratum 3 on the deciduous shrub fen plot.

Figure 34. Open bog plot, 1977.

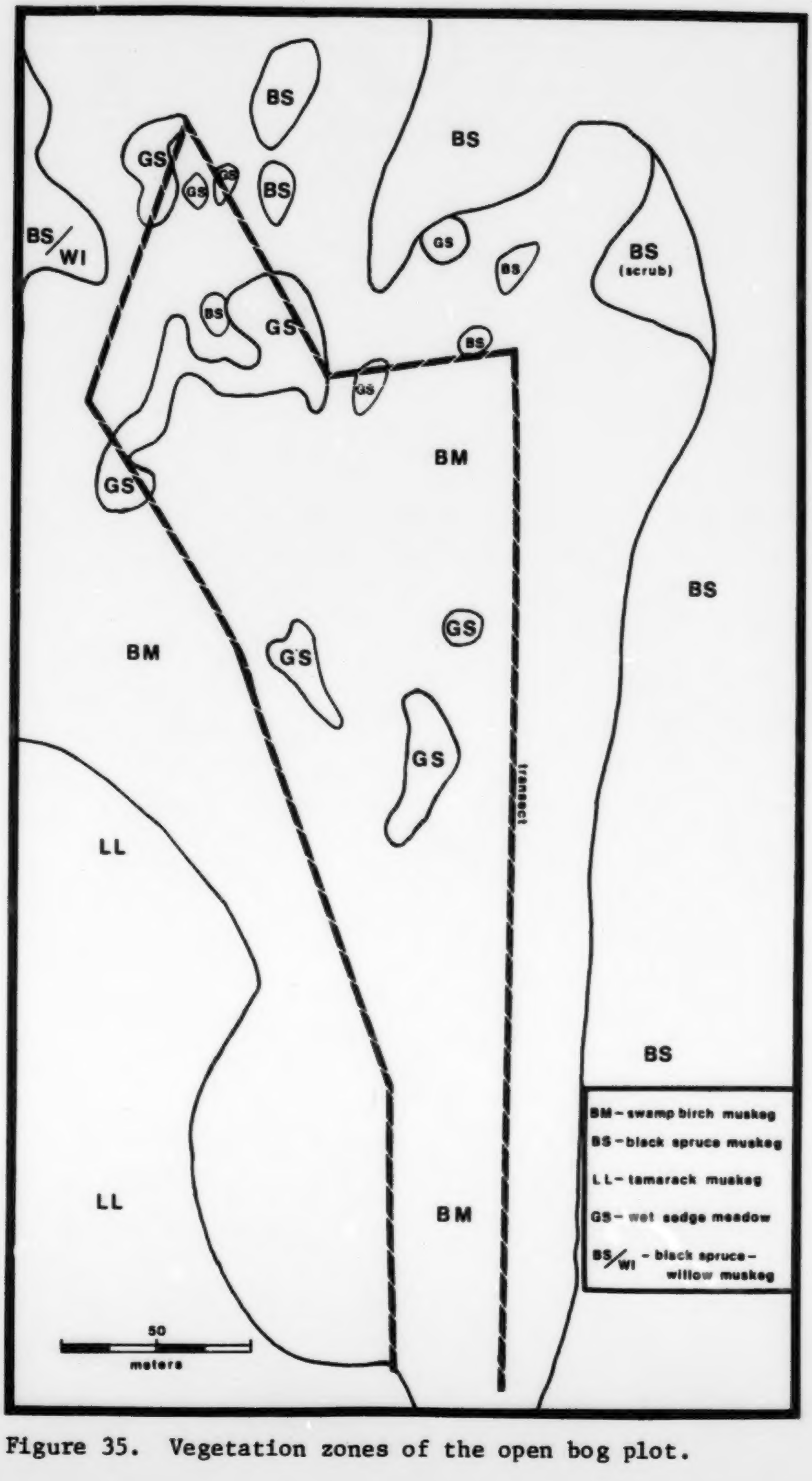

BS
BS
GS
GS
GS
BS
BS/WI
GS
BS
BS
BS
(scrub)
GS
BS
GS
BS
GS
BM
GS
GS
BS
BM
GS
GS
transect
LL
BS
BM - swamp birch muskeg
BS - black spruce muskeg
LL - tamarack muskeg
GS - wet sedge meadow
BS/WI - black spruce - willow muskeg
LL
BM
50
meters

Figure 35. Vegetation zones of the open bog plot.

Stratum 2 was dominated by bog birch which most often formed a dense canopy that was 0.75 m tall. The only other species present in this stratum was willow which in some areas formed 5 to 20% of the canopy. The willow was restricted to the eastern end of the plot.

The canopy of Stratum 1 was usually dense and of variable composition. Shrubs and sedges were the common plant types in this stratum with shrubs, swamp birch, willow, and leather-leaf (*Chamaedaphne calyculata*), being dominant.

Areas totally dominated by sedge had higher percentages of forbs than surrounding areas of bog birch. Buckbean (*Menyanthes trifoliata*), water hemlock (*Cicuta bulbifera*), dock (*Rumex occidentalis*), and marsh marigold (*Caltha palustris*) were the common forbs in these areas. Forbs were sparse or absent in areas dominated by swamp birch.

A thick layer of moss was present over the entire plot. The organic soil was saturated and small areas of open water were present.

Standing dead conifers (averaging 6 m in height) and shrubs were abundant within the plot. Areas of standing dead willow were common on the east end of the plot. Dead sedges constituted the major form of detritus.

7.3.15 Sedge Fen Plot

This transect followed the interface of a wet sedge-willow fen and a mixed forest on dry sandy soil. The fen vegetation comprised sedge, reed grass (*Calamagrostic* spp.) and willow. Sedge and reed grass formed a closed canopy ranging in height from 0.75 to 1 m tall, when surveyed in August. Willow varied from scattered to closed and had a mean height of 3 m. Willow reached heights of 5 m or more along the interface but these did not form extensive areas. Scattered clumps of tree size aspen were present on the fen.

A very saturated soil with small pools of water typified the drainage of the fen. Mosses were sparse and a detritus layer of dead grass and sedge was present. Standing dead trees, both coniferous and deciduous, were common around the perimeter of the fen. Some areas had very high densities of standing dead trees.

Jack pine, aspen, paper birch, and white spruce, together forming a generally dense canopy 8 to 12 m in height, were present in varying amounts in Stratum 3 of the mixed forest surrounding the fen.

Stratum 2 comprised alder, rose, paper birch, willow, and aspen, averaging 3 m in height and forming a canopy that was generally dense.

Shrubs were the important component in Stratum 1 with forbs varying considerably. Fallen trees and the detritus layer, composed of deciduous leaves, were both sparse. Standing dead trees were present on most blocks. Lichens and mosses were sparse on the dry sandy soil. The slope of the ridge was slight to moderate.

7.3.16 Young Black Spruce

The young black spruce plot was 35 ha in size and was located 6 km south of the confluence of Hartley Creek and the Muskeg River. The stand was located on a site that apparently burned some time between 1935 and 1940. One corner included 1.25 ha of unburned habitat, a very mature tamarack-alder-willow swamp. The rest of the plot was of uniform age (See Table 59).

The dead spars which were still identifiable suggested that the previous forest had been a mixture of tamarack, black spruce, and jack pine 6 to 15 m tall. The few trees that survived the fire were all black spruce or tamarack.

The tamarack-alder-willow swamp has an open to dense tree canopy of 15 m tall tamarack and 8 to 12 m tall alder (*A. tenufolia*) and willow. Stratum 2 comprised the same species at similar densities but 3 to 4 m in height. The ground cover was dominated by *Equisetum* spp. and grasses; marsh marigolds, bearberry, and Labrador tea were also present.

Table 59. Ages and heights of tree species sampled on the young black spruce plot.

Species	Height (metres)	Age
Black spruce	4	39
Black spruce	4	41
Black spruce	2	40
Black spruce	1	36
Balsam poplar	5	41

The soil was saturated and organic; pools of water up to 0.5 m deep covered roughly 50% of the ground.

The Stratum 3 canopy in the young black spruce portion of the plot (33.75 ha) varied from absent to open, but was scattered in most blocks. Pure black spruce 5 to 6 m tall was the most common tree cover, although one 4.25 ha area had a canopy of 6 to 12 m tall trembling aspen and jack pine.

Stratum 2 varied from open to closed but was most often dense or open-to-dense. Black spruce dominated the stratum, generally constituting 80 to 100% of the stratum. Black spruce frequently formed two fairly distinct layers, one at 1 to 2 m, the other at 2.5 to 4 m. Willow was present in about half of the blocks, and when present it generally constituted 3 to 20% of the stratum and was 1.5 to 2.5 m tall. Swamp birch, tamarack, Labrador tea, and *Potentilla fruticosa* were also occasionally present in Stratum 2.

Stratum 1 was usually dense or open to dense, comprising roughly equal amounts of shrubs, grasses and *Equisetum*. Forbs, sedges, rushes, and very small black spruce were occasional minor components of this stratum. The dominant species of shrubs in the ground cover layer were Labrador tea and bearberry.

Mosses generally formed a dense carpet, while lichens were only present in drier areas.

The plot was flat, with poorly drained organic soil. The moisture regime ranged from wet to saturated, and tiny shallow pools of standing water were common.

7.3.17 Mature Black Spruce Plot

This 16.5 ha plot was situated in an area dominated by mature black spruce which formed a dense canopy averaging 11.3 m in height. The variability of the foliage height diversity on the plot is illustrated in Figures 25 and 26. Black spruce was the dominant species of Stratum 3 with tamarack occurring predominantly along the interfaces where the black spruce muskeg abutted areas of scrub coniferous muskeg or swamp birch muskeg. The tamarack averaged 9 m in height and usually formed a scattered canopy.

Characteristic of the entire plot was the sparsity of Stratum 2. Tamarack, swamp birch, and black spruce, which was most common and averaged 1.5 m in height, were all present at scattered densities.

Stratum 1 was generally open or scattered and very rarely dense. This stratum was dominated by dwarf shrubs consisting of bog cranberry, labrador tea, black spruce, willow, swamp birch, and tamarack. Sedges, forbs, and horsetail, if present at all, rarely formed more than 5% of the ground stratum canopy. This open forest floor was covered by a thick layer of moss and occasionally by a layer of lichen.

7.3.18 Bitumount Muskeg Plot

The Bitumount muskeg plot sampled a mixture of water-saturated habitats, a commonly occurring situation in the southern half of the AOSERP study area. Five basic habitat types were present on the plot: black spruce muskeg, tamarack fen, willow muskeg, willow fen, and hydric mixed forest.

Stratum 3 in the tamarack fen was open to dense; tamarack trees varied from 5 to 14 m in height and averaged approximately 10 m.

Stratum 2 in this section was dense and consisted of 1 to 2 m tall swamp birch (*Betula pumila*). Stratum 1 in the tamarack and willow fens was dense to closed and was heavily dominated by sedges and horsetails.

Small mossy hummocks were common in both the willow and tamarack fens; otherwise, the water table was at or above the soil surface. No tree canopy was present in the willow fen and willow muskeg areas. Stratum 2 was dense to closed in the willow fen, open to dense in the willow muskeg, and was dominated by 1.5 to 3.5 m tall willow. A scattered to open layer of 1 m tall swamp birch was present between and beneath the willows, and 1 to 4 m tall black spruce and tamarack were scattered through these areas. Scattered 0.5 m tall shrubby cinquefoil was also present in the willow muskeg.

Stratum 1 in the willow muskeg, hydric mixed forest and black spruce muskeg was fairly consistent in species composition. Densities varied from open to dense in the black spruce muskeg, and from dense to closed in the other two habitats. Shrubs, mainly willow, swamp birch, shrubby cinquefoil, and labrador tea were the main component in the ground stratum, although grasses and sedges were also present in significant amounts. Forbs and baltic rush (*Juncus balticus*) were minor components in most blocks in these areas. While all three habitats were characterized by saturated soil, the water table was much closer to the surface in the black spruce muskeg than in either the willow muskeg or the hydric mixed forest. Mosses and lichens were common in the latter two habitats, whereas a lush carpet of mosses was present in the black spruce muskeg.

Stratum 3 in the black spruce muskeg was generally open and varied from 5 to 13 m tall, averaging 8.5 m.

Stratum 2 was generally open; black spruce 2 to 4 m tall dominated, but willow, swamp birch, and shrubby cinquefoil were also present. The tree canopy in the hydric mixed forest was generally open or scattered, but varied considerably in height and species composition. The compcnents were, in order of dominance: black spruce, 5 to 18 m tall; balsam poplar, 5 to 10 m tall; willow, 5 to 8 m tall; trembling aspen, 5 to 18 m tall; white spruce, 5 to 10 m tall; and jack pine, 5 to 8 m tall. Stratum 2 beneath this tree canopy was generally dense. Willow 2.5 to 4 m tall dominated, but black spruce 1.5 to 4 m tall was also common. Also present in most blocks in this area were 2 to 4 m tall balsam poplar, 1 to 1.5 m swamp birch, and 0.5 m tall shrubby cinquefoil.

7.3.19 Tamarack Plot

The tamarack plot was 37.0 ha in size and was located 5.5 km north of the confluence of the Muskeg River and Hartley Creek. The tamarack on this plot were very old but stunted: trees in the range of 1.5 to 3 m in height averaged 170 years old. Taller specimens, reaching a maximum of 7 m, were an average of 240 years old.

In a few blocks, scattered tamaracks attained heights of 7 m but, for most of the plot, no foliage was present in Stratum 3. Figure 36 illustrates the size and form of the tamarack on this plot.

Stratum 2, which was open with an occasional dense patch, consisted invariably of tamarack and swamp birch. The tamarack was generally scattered and averaged 2.7 m in height while the swamp birch was generally open and averaged 1.1 m in height.

Stratum 1 varied from open to closed and was dominated by sedges. Buckbean and swamp birch were also present but usually at low densities.

Mosses were abundant on this plot and consisted of *Sphagnum*-type mosses which formed hummocks, and aquatic mosses which were present in the numerous small pools. This plot was situated next to a shallow lake and the soil for the entire area was saturated.

7.4 INSTRUCTIONS FOR WINTER UPLAND BIRD CENSUS

01-06	Date	
07	Observer	
08-09	Plot number	
10-12	Point of origin: Grid location at which survey is started	
13	Sequence (census number)	
14-15	Starting temp.: Degrees Celcius	
16	Wind at start: Use Beaufort Scale	
17-18	Cloud at start: Use tenths	
19-20	Precipitation at start: Intensity and type of precipitation	
	i - intermittent	0 - nil
	s - light	1 - fog
	m - moderate	2 - drizzle
	h - heavy	3 - showers
		4 - thundershowers
		5 - rain
		6 - snow flurries
		7 - snow

Figure 36. Distribution of tamarack and swamp birch on the tamarack muskeg plot.

21-27	Finish headings are the same
28-31	Start time
32-35	Finish time
36-38	Location: Grid location where bird(s) are sighted
39-40	Species: RG - ruffed grouse PT - ptarmigan SG - spruce grouse UI - unidentified SH - sharptailed grouse
41	Age: A - adult J - juvinile U - undetermined
42	Sex: M - male F - female U - undetermined
43-44	Number if in a flock
45-46	Number of males and females identified in flock
47	Check if identified by sound
48	Check if identified by sight
49-50	Distance from survey line: This is the distance to the spot perpendicular from the transect line at which the bird was flushed or spotted.
51-52	Distance from the observer: This is the distance between the observer and the spot where the bird(s) was(were) spotted.
53-54	Direction from the observer: This is the compass bearing taken from the observer to the spot where the bird(s) flushed.
55-56	Activity at sighting: This is the activity of the bird(s) when first perceived. SI - sitting or perching BU - burrowed in or flushed from under the snow FL - flying FE - feeding RU - running
57-58	Subsequent Activity: This refers to the activity of the bird(s) in response to the observer. FR - "freezing" or crouching behaviour RU - running from observer FL - flushed into flight CO - continuation of previous activity

59-60 Plant species associated with: Record the plant species the bird(s) were directly associated with. For example: feeding on, sitting in, etc.

61-62 Location of bird in vegetation: The distance in metres measured from the snowline to the spot in the plant where the birds were feeding or sitting; or the distance from the nearest plant if the bird is located on the ground.

63-64 Cover type of area: Dominant cover type of the area where the bird was flushed. Use two letter symbols provided.

65-66 Residual vegetation density: Record the density of the vegetation in the zone from the snowline to 1 m above the snowline. Herbs, grasses, and shrubs are all classed together as the residual vegetation remaining above the snowline. Vegetation extending beyond 1 m from the snowline is not used for the density estimate. This should be recorded for each grid unit every survey.

ba - barren snow, no cover
tr - trace cover
mo - moderate cover
de - dense cover

67-68 Residual vegetation distribution: This refers to the distribution pattern of this cover. This should be recorded for each grid unit every survey.

co - continuous
in - interrupted, discontinuous
pa - in patches, tufts, clumps
sp - sparse, randomly dispersed single plants

69 - 70 Snow depth: cm

71 Snow condition: A qualitative description is made of the type and condition of the snow.

F - fresh or light snow, 15 cm deep
O - old granular snow

C - frozen or crusted snow
S - light snow, 15 cm deep over frozen, crusted snow
W - wet snow
P - patchy (i.e., spring condition)

72-75 Percent slope and aspect of snow surface

76-77 Food material if eating: BE - berries
BU - buds, catkins, etc.
LE - leaves
GR - grass seeds

78-79 Distance to nearest interface: metres

80-81 Type of interface: Record the adjoining covertype (See 63-64)

7.5 WINTER UPLAND BIRD CENSUS FORM

Plot Census Record: Migratory and Upland Birds C.W.S. /A.O.S.E.R.P.

Date: ______________ Observer: ______________ Start - Temp: __ __ Wind: ____ Direc: __ __ Precip: __ __

Plot No.: __ __ Pt. of origin: __ __ __ Finish - Temp: __ __ Wind: ____ Direc: __ __ Precip: __ __

Sequence: ________

Page ____ of ____ Start Time: __ __ __ __ Finish: __ __ __ __

Location	Species	Age	Sex	No.(if flock)	No. of M. and F in flock		Ident. sound	Ident. sight	Dist from survey line	Dist. from Observer	Direction from Obs. (compass)	Activity at sighting	Subsequent activity	Plant spp. ass. with	Loc. of bird(s) in veg.	Cover type of area	Residual veg density	Residual veg distribution	Snow depth at contact	snow condition	% Slope & direction of snow surface	food mat. if eating	Dist. to nearest interface	Type of interface
					M	F																		

7.6 INSTRUCTIONS FOR WINTER UPLAND HABITAT DESCRIPTION

01-06 Date

07-08 Plot number

09-10 Observer
1 - Hennan
2 - Francis
3 - Lumbis
4 - Bradley

11-13 Habitat unit: The first number refers to the line number and the second and third numbers refer to assigned points on the transect line.

14-15 Slope

16-17 Aspect

18-19 Cover type: This identification code refers to the dominant vegetative community type of the unit. The dominant tree species is indicated by the first letter.

PJ - jack pine
PA - jack pine-deciduous
PS - jack pine-mixed spruce
PW - jack pine-white spruce
PB - jack pine-black spruce
PM - jack pine-spruce-deciduous
BL - black spruce
BA - black spruce-deciduous
BP - black spruce-pine
BW - black spruce-white spruce
BT - black spruce-tamarack
BM - black spruce-pine-deciduous
WH - white spruce
WP - white spruce-pine
WB - white spruce-black spruce
WA - white spruce-deciduous
WM - white spruce-pine-deciduous
MA - mixed spruce-aspen
MP - mixed spruce-jack pine
AS - deciduous forest
AW - deciduous-white spruce
AB - deciduous-black spruce

AP - deciduous-jack pine
AM - deciduous-spruce-pine
BR - brushland or old burn
TM - black spruce and/or tamarack muskeg
MU - herb-shrub muskeg
WE - wetland complex or lake shore

20-21 Stratum type: This code refers to the types of strata present in the vegetative community. Each stratum is not necessarily present in each community. Each stratum will be described on a separate line.

Th - trees high >10 m
Tm - trees medium 5-10 m
Tl - trees low <5 m
HH - herbs high >1 m
HM - herbs medium 0.5-1 m
HL - herbs low <0.5 m

SH - shrubs high 2-5 m
SM - shrubs medium 0.5-2 m
SL - shrubs low 0.5 m

22-23 Stratum distribution: This code refers to the distribution pattern of the vegetation forming the stratum.

c - continuous
i - interrupted, discontinuous
p - in patches, tufts, clumps
s - sparse, randomly dispersed single plants

24-29 Plant species: List of 3 or less species that dominate each stratum. A list of two letter symbols is provided.

30-31 Depth: cm

7.7 WINTER UPLAND BIRD HABITAT DESCRIPTION FORM

CWS/AOSERP

UPLAND-BIRD CENSUS PLOTS:

HABITAT DESCRIPTION

DATE: ____ ____ ____

PLOT NO.: ___ ___

OBSERVER(S): ___ ___

HABITAT UNIT	TOPOGRAPHY		COVER TYPE	STRATUM TYPES	STRATUM DISTRIB.	DOMINANT PLANT SPECIES	SNOW DEPTH	NOTES
	SLOPE	ASPECT						

7.8 INSTRUCTIONS FOR TERRESTRIAL BIRD MIGRATION CENSUS

AOSERP: Avifauna

Instructions for use of Migration Surveys Data Form

1. Line point: Location on plot or transect; 3 digits, includes on decimal point.
2. Distance from line: Metres
3. Side of line: Left (L) or right (R)
4. Flock #: Including migrant singles, but not including gallinaceous birds, stationary (non-migrant) birds, birds classified as "uncertain", and extraneous observations (e.g., ducks, squirrels, etc.)
5. Family groups (shorebirds to unid - passerines): x = present; blank = absent. For numbered flocks only.
6. Status: 0 (blank) - migrant
   1 = uncertain (e.g., ravens, chickadees, etc.)
   2 = stationary birds (e.g., woodpeckers, etc.)
   3 = grouse
   4 = extraneous observations (e.g., ducks, etc.)
   5 = mammals
   6 = flybys - for which habitat is unknown
7. Species: (classify unids as far as possible)
8. Age of young: 1 = egg 4 = crashing & burning
   2 = nestling 5 = fledgling
   3 - unable to fly 6 = subadult
9. Behavior: 1 = flit/feed
   2 = feeding
   3 = calling
   4 = singing (i.e., territorial song)
   5 = territorial display/courtship display
   6 = left area
   7 = arrived from elsewhere
   8 = carrying food or nest material
   9 = distraction display (i.e., indicating nest or young)

10.	Microhabitat: Description e.g., location (height) of birds in tree. Species of tree. Size of tree. etc.
21-27	Finish headings are the same
28-31	Start time
32-35	Finish time
36-38	Location: Grid location where bird(s) are sighted
	Species: RG - ruffed grouse PT - ptarmigan SG - spruce grouse UI - unidentified SH - sharptailed grouse
41	Age: A - adult J - juvinile U - undetermined
42	Sex: M - male F - female U - undetermined
43-44	Number if in a flock
45-46	Number of males and females identified in flock
47	Check if identified by sound
48	Check if identified by sight
49-50	Distance from survey line: This is the distance to the spot perpendicular from the transect line at which the bird was flushed or spotted.
51-52	Distance from the observer: This is the distance between the observer and the spot where the bird(s) was spotted.
53-54	Direction from the observer: This is the compass bearing taken from the observer to the spot where the bird(s) flushed.

7.9 TERRESTRIAL BIRDS: MIGRATION TRANSECT CENSUS FORM

DATE	Obs	Site	Plot	Time	Cloud tenths	Wind B.S.	Sun.Wind Direc.	Wind direc.	Temp. oC.	Precip intensity, type	Daily Weather:
START											
FINISH											

Line	Dist.	Side	Flock no.	Sparo.	Flycat.	Titmice	Thrush	King.	Vireo	Warb.	Black.	Fring.	Other	Unid.	No. in Flock	Status	Species	Adults			Young		Beh.	Micro habitat \ Remarks
																		no. ♂	no. ♀	no.	no.	age		

7.10 HABITAT DESCRIPTION FORM: TERRESTRIAL BIRD MIGRATION TRANSECTS

HABITAT DESCRIPTION: MIGRATORY BIRDS

MIGRATION TRANSECTS, AOSERP/AVIFAUNA

DATE:____________________ OBSERVATION:________________________ SITE:____________________ TRANSECT:________________

Habitat Block		Upper Canopy Density	Canopy Ht. & most dense layer	Species Comp.			Shrub Density	Shrub Ht. & most dense layer	Shrub Species Comp.			Ground Cover Density	Ground Cover Species			Moss/ Lichen Density	Dead-wood	% Bare Ground

7.11 INSTRUCTIONS FOR TERRESTRIAL BREEDING-BIRD CENSUS

Passeriness and Upland Species

AOSERP/AVIFAUNA

Observer: 1. J. Francis
2. R. Palindat
3. K. Lumbis

Site: 1. Bitumount
2. McClelland Lake
3. Syncrude Lease 17

Plot: A. Bitumount
1. Treed muskeg
2. River transect
3. Mixed forest
4. Pure aspen
5. Migration transect: mixed forest: spring
6. " " aspen
7. " " muskeg
8. Island transect
9. River shorebird transect
10. Fall mixed forest transect

B. McClelland Lake
1. Park-like jack pine
2. Bog-edges transect
3. Aspen-dominated forest
4. Scrub jack pine
5. Migration transect: spruce aspen
6. " " shore/jack pine
7. " " bog/aspen-jack pine

C. Syncrude Lease 17
- mixed forest transect

Time: Start and end of survey

Cloud (tenths): Portion of sky obscured by clouds (other than transparent cirrus).

Wind: Average (gusts should be mentioned in "daily weather"). Beaufort Scale. Surveys should be postponed or discontinued at winds above Beaufort Scale = 3.

Surface wind direction: In degrees, true, of 8 points of the compass.

Upper wind direction: Determine by cloud movement. Leave blank if unable to ascertain.

Temperature °C:

BR - A bird giving some evidence of breeding: i.e., courtship, nest-building, carrying food, giving distraction or aggression displays, etc.

FB - Flyby: songbird seen flying by; i.e., present in area but no habitat affinity ascertainable.

U - Songbirds not fitting any of the above categories (i.e., most observations).

MAM - Mammals

GR - Gallinaceous birds

X - Extraneous observations, e.g., waterfowl

RAPT - Raptors

Species: Enter species if known; or, if uncertain, genus, family, or order.

Total number:

#: Number of adult males

#: Number of adult females

# UNK: Number of adults or unknown sex

# Young: Number of young

Age of Young: Egg. Nestling. Unable to fly (for shorebirds). Crashing and burning (i.e., motile but not mobile). Fledging. Sub-adult.

Abbrev.: Egg. Nst. Ufl. CB. Fl. Sub.

Behaviour: When first observed

FF - flit/feed

FD - feed (definite)

DR - drum

TO - took off (and left)

CNS - carrying nest material

CFD - carrying food

CT - courtship display

TD - territorial display

FL - flush
LD - landed (arrived from elsewhere)
SG - singing (territorial song)
CLG - non-territorial vocalization
HT - Hunt
PCH - perch
FB - flyby (i.e., not habitat associated)
DD - distraction display

Second behaviour: Notably, response to observer - e.g., protection or distraction displays.

Microhabitat/Remarks: Any relevant comments, plus, if observable, a description of where the bird was: e.g., on the forest floor, in grass or moss; 12 m up in a 30 m white spruce (record as 12/30 SW), etc.

INSTRUCTION FOR BREEDING BIRD PLOT MAPS: PASSERINES AND UPLAND SPECIES

AOSERP/AVIFAUNA

ALIGN YOUR MAP SUCH THAT THE LINES YOU WALK ARE UP AND DOWN THE SHEET - NOT SIDEWAYS.

WHEN A BIRD IS OBSERVED, LOCATE IT ON THE MAP WITH A CIRCLE.

AND INDICATE THE DIRECTION YOU HEARD IT FROM WITH A 1/16" RAY. AND FURTHER RAYS IF YOU HEAR IT AGAIN.

IF THE BIRD IS DISTINGUISHABLE AS TO SEX, SO INDICATE.

IF THE BIRD MOVES, SO INDICATE WITH AN ARROW, DO NOT USE SHORT ARROWS FROM THE UPPER RIGHT HAND CORNER OF THE CIRCLE. RATHER:

IN THE CIRCLE, WRITE THE SPECIES OF THE BIRD AND A NUMBER. USE A NEW NUMBER FOR EACH BIRD - THIS IS THE "CONTACT REFERENCE NUMBER" AND WILL BE USED TO IDENTIFY THE BIRD ON THE DATA SHEET.

IF THE BIRDS OF THE SAME SPECIES ARE HEARD SIMULTANEOUSLY - SO INDICATE BY DRAWING A "RAILROAD" LINE HALFWAY BETWEEN THEIR CIRCLES. IF THE MAP IS CROWDED ENOUGH TO CAST SOME DOUBT ON WHICH PAIRS OF BIRDS ARE INVOLVED, LABEL THE LINE WITH THEIR CONTACT REFERENCE NUMBERS.

IF AN OBSERVATION IS MADE OF A BIRD WHICH MAY OR MAY NOT BE THE SAME AS A BIRD PREVIOUSLY RECORDED, RECORD IT ANY WAY AND MENTION YOUR DOUBT IN "COMMENTS" ON THE DATA SHEET. IF YOU STRONGLY SUSPECT THE TWO ARE THE SAME BIRD, JOIN THE TWO CIRCLES WITH A LINE. DO NOT USE AN ARROW.

IF A FLOCK OF MIGRANTS IS ENCOUNTERED, THEY SHOULD BE RECORDED WITH A CIRCLE (OR OBLONG IF THE FLOCK IS SPREAD OUT) AND GIVEN A NUMBER, ENDING WITH X. THEIR SPECIES MAKEUP SHOULD BE RECORDED AS A GROUP (I.E., WBVIRSP - WARBLER AND VIREO SPP.) RATHER THAN EXPLICITLY.

ALL OTHER DATA SHOULD BE RECORDED ON THE BREEDING BIRD DATA SHEET OR THE MIGRANT BIRD DATA SHEET, ALWAYS USING THE CONTACT REFERENCE NUMBER.

ALL IN ALL, A FINISHED PLOT MAP OUGHT TO BE A PRETTY BAROQUE AFFAIR.

7.12 TERRESTRIAL BREEDING-BIRD CENSUS FORM

BREEDING BIRD (PASSERINE) CENSUS AOSERP / AVIFAUNA

DATE:	OBS	Site	Plot	Start Point	Cov.	Time	Cloud (tenths)	Wind (B.S.)	Surf wind Direc.	Surf wind Direc.	Temp. (°C)	Precip intens Type	Daily Weather :
Start													
Finish													

Contact Ref. No.	Habitat Block	Status	Species	Total No.	Adults			Young		First Beh.	Sec. Beh.	Microhabitat / Remarks
					No.	No.	No. Unk.	No.	Age			

7.13 HABITAT DESCRIPTION INSTRUCTIONS: TERRESTRIAL BREEDING BIRD CENSUS PLOTS AND TRANSECTS

Block number: Grid reference: Use co-ordinates from plot map with Y-axis followed by X-axis (e.g., 7-2).

General habitat type: A two-letter symbol denoting the general vegetative composition and physiognomy of the entire block:

PB - jack pine forest
PA - jack pine-aspen forest
PS - jack pine-spruce forest
PM - jack pine-aspen-spruce forest
SW - white spruce forest
SA - white spruce-aspen forest
SP - white spruce-pine forest
SM - white spruce-pine-aspen forest
BP - balsam poplar forest
AN - aspen forest
AP - aspen-pine forest
AB - aspen-birch forest
AS - aspen-spruce forest
AM - birch forest
BT - black spruce/tamarack muskeg
BS - black spruce forest
WI - shrub (willow) muskeg
WU - shrub upland
GS - sedge-grass wet meadow (fen)
GD - sedge-grass dry meadow
GR - grass-sedge wet meadow
GM - grass-sedge dry meadow
DM - grass-forb dry meadow
LM - lichen-moss

Any of the above symbols followed by an exponential asterisk will denote a "scrub" situation; i.e., generally, a dense second-growth condition (e.g., AN* is scrub aspen).

Stratum level: Categorize vegetation according to the following three height strata:

Stratum 1 - all living plants to a height of 0.5 m.
Stratum 2 - plants from 0.5 to 5 m.
Stratum 3 - plants taller than 5 m.

Overall canopy or cover density: A visual estimate, for the entire block, of the density of the vegetation of each stratum. In the case of Stratum 3, if two distinct levels of canopy are present, both are included in the density estimate. Lichen and moss should not be included in the ground cover density description; they are dealt with separately on the form. Note that the terms refer to distribution as well as density.

ST = scattered: The space between the crowns of the individual plants of the stratum exceeds the space occupied by the plants themselves.

SC = scattered-clumped: The plants of the stratum occur in groups with the spar between the collective crowns of the groups exceeding the spar occupied by the crowns.

OP = open: The crowns of the plants of the stratum are separated by spaces at least equal to their diameters but not more than twice their diameters.

DN = dense: The crowns of the plants of the stratum are separated by spaces up to the equivalent of their diameters.

CL = closed: The crowns of the plants of the stratum are predominantly touching or overlapping.

Species 1-5: Insert the five most dominant species (or fewer, if fewer than five occur) in order of prevalence and describe according to:

D (density/distribution): Use the categories and symbols listed for overal canopy/cover density, applying them to the crowns of the indicated species only.

C (relative density): The proportion of crown space in the stratum occupied by the indicated species relative to all other species; expressed as a percentage.

H (height): Average height, in metres, of the plants of the given species.

Standing dead trees: Identify species where possible, and record an estimate of the number of spars in the block (2500 m^2), and their average height, in metres.

Where two tree canopies present: If two distinct canopy layers are present in the tree stratum, describe both layers according to type, density, and height.

Type: DE = deciduous
CO = coniferous
MI = mixed

Density categories will be the same as those used in describing the overall canopy.

Non-living plant material: (Other than standing dead trees) List in order of prevalence, dead plant materials which occur in adjudged significant amounts, according to:

Type: DL = deciduous leaves
Cl = coniferous leaves (needles)
BR = tree and shrub branches
FT = fallen trees
DS = dead shrubs and trees ?5 m (standing)
DG = dead grass or sedge
DF - dead forbs

DEN (Density): S = sparse
C = common
D = dense

Interfaces: An intrusion of a second major vegetative type having a diameter of 20 m or great and occurring wholly or partially within a given block will present an interface to be described according to:

Type: Record as Hab. 1/Hab. 2 where Hab. 1 is the habitat type described for the block in general and Hab. 2 is the intruding habitat.
Use the symbols provided for "General Habitat Type". Use /Hab. 3 where necessary.

J (Juxtaposition): The relative height relationship of the interfacing habitats:
+, where Hab. 2 is taller
-, where Hab. 2 is shorter
0, where Hab. 1 and 2 are essentially the same height.
H_2 = average height, in metres, of Hab. 2.
S = size of interface, recorded as:
1 = ?20 m, ?50 m.
2 = ?50 m.

Lichen-Moss Den: Lichen and/or moss density.
Recorded as: S = sparse
C = common
D = dense
N = none.

Soil-Texture: Recorded as: C - clay.
SIC - silty clay.
SC - sandy clay.
CL - clay loam.
Si - clay loam.
SiL - silty loam.
L - loam.
SL - sandy loam.
LS - loamy sand.
S - sand.
Or - organic (peaty).

Soil-Drainage: Recorded as: D = dry. Well or rapidly drained.
F = fresh. Moderately well drained.
M - moist. Imperfectly drained.
W = wet. Poorly drained.
S = saturated. Very poorly drained. Free water remains at or within 30 cm of surface most of year. Mucky or peaty soils.

Topography: Within the block.

Form: Ra - ravine
Bi - bluff
Kn - knoll
De - depression
Ir - irregular
Fl - flat
Sl - continuous slope within block

S (Slope): 0 = flat
1 = slight: up to 15°
2 = moderate: $15 - 45^{\circ}$
3 = steep: $?45^{\circ}$

A (Aspect): N, S, E, W (or combinations).

Water: Record surficial water within or 25 m from block, as:
La - lake, >500 m diameter.
Po - pond, <500 m diameter, mostly open
Bo - bog, acidic.
Ma - marsh, fresh, mostly vegetated.
Ri - river, >10 m across.
Cr - creek, <10 m across.

7.14 HABITAT DESCRIPTION FORM: TERRESTRIAL BREEDING-BIRD CENSUS PLOTS AND TRANSECTS

HABITAT DESCRIPTION: MIGRATORY BIRDS CENSUS PLOTS AND TRANSECTS

AOSERP/AVIFAUNA

DATE: ____________ OBSERVER: ____________ SITE: ____________ PLOT: ____________

Block Number	Gen. Hab. Type	Stratum Level	Overall Canopy or Cover Density	Species 1				Species 2				Species 3				Species 4				Species 5				Standing Dead Trees			Where 2 Tree Canopies Present						Non-Living Plant Material	
																											Upper Canopy			Lower Canopy				
				SP	D	C	H	SP	D	C	H	SP	D	C	H	SP	D	C	H	SP	D	C	H	SP	D	H	TYPE	D	H	TYPE	D	H	TYPE	DEN

(see reverse)

Block Number	Interfaces				Lichen-Moss	Soil		Topography			WATER	NOTES AND ILLUSTRATIONS
	TYPE	J	H_2	S	DEN./DIS	TEXT.	DRAIN.	S	A	FORM		

7.15 INTERPRETIVE TECHNIQUES

7.15.1 Derivation and Usefulness of the C.I.N.

Table 60 illustrates the derivation of C.I.N. values from three hypothetical sets of raw population data. Data set A represents a high population year for Ovenbird, Red-eyed Vireo, and Tennessee Warbler. Data set B represents the same forest in a low population year for these species. Note that while the total population and B.S.D. index fluctuate considerably (and in opposite directions!) the C.I.N. value remains stable. This aspect of the C.I.N. renders it useful for comparing habitats not sampled in the same year. Data set C represents an imperfect sample of the same aspen forest, a sample containing a small ravine, two small brushy clearings, and a few scattered copses of spruce and pine. The ten bird species associated with these impurities affect the total population, species richness, and B.S.D. index, but not the C.I.N. As perfectly homogeneous habitat samples are almost impossible to find, this aspect of the C.I.N. is of considerable importance.

Thus, while population fluctuations and the presence of bird species occupying marginal and incidental niches cause total population, species richness and the B.S.D. function to fluctuate wildly, the C.I.N. remains stable, reflecting the number of species for which a habitat type is suitable.

The limitation of the C.I.N. is habitat mixtures: homogeneous mixed habitats present no problem, but the C.I.N. should not be applied to non-homogeneous habitats. If a study plot consists of equal proportions of two habitats, the C.I.N. would generally "register" most if not all of the species for which either habitat is suitable. This would result in an inordinately high number. If a plot consists of small amounts of many different habitat types, nearly all species would appear to be "incidental". Thus, in this instance, the C.I.N. would "register" only those bird species for which at least two of the habitat types are suitable. This would

Table 60. Three data sets for hypothetical aspen forests, illustrating the derivation and usefulness of the C.I.N.

	Bird Species (Maximum density in parentheses)	Population data set A. (Percent of maximum density in parentheses)	Population data set B	Population data set C
Ovenbird	(138)	100(73%)	40(29%)	40(29%)
Tennessee Warbler	(112)	100(89%)	40(36%)	40(36%)
Red-eyed Vireo	(126)	100(79%)	40(32%)	40(32%)
Swainson's Thrush	(52)	25(48%)	25(48%)	25(48%)
Black-and-white Warbler	(34)	15(44%)	15(44%)	15(44%)
Rose-breasted Grosbeak	(17)	15(88%)	15(88%)	15(88%)
HermitThrush	(24)	15(63%)	15(63%)	15(63%)
Black-capped Chickadee	(12)	5(42%)	5(42%)	5(42%)
Hairy Woodpecker	(8)	5(63%)	5(63%)	5(63%)
Canada Warbler	(56)			3(5%)
Mourning Warbler	(25)			3(12%)
American Redstart	(197)			25(13%)
Least Flycatcher	(195)			25(13%)
Bay-breasted Warbler	(63)			3(5%)
Chipping Sparrow	(75)			9(12%)
Dark-eyed Junco	(112)			9(8%)
Warbling Vireo	(23)			3(13%)
Western Tanager	(23)			3(13%)
Purple Finch	(30)			3(10%)
Total Population		380	200	286
Species Richness		9	9	19
C.I.N.		9	9	9
Shannon-Weaver Function (B.S.D. Index)		1.73	1.99	2.57

result in an inordinately low number. Suffice to say, the C.I.N. should be applied only to study plots which are heavily dominated by one habitat type.

The C.I.N., and the species/habitat saturation histograms, are only as good as the species density maxima from which they are derived. These maxima are discussed later in this appendix.

7.15.2 Derivation and Usefulness of the Species/habitat Saturation Histogram

Figure 37 illustrates the derivation of two species/habitat saturation histograms from raw population data.

The species/habitat saturation histogram illustrates graphically the approximate degree of suitability of a habitat for each bird species (Figure 38). That is to say, it illustrates which species are occupying marginal or incidental niches, and which are integral to the habitat. For habitat mixtures, it illustrates which species find more than one component "type" suitable.

The two data sets in Figure 37 both involve the same bird species. Thus the fact that habitat "B" supports at least slightly higher abundance of all species (and considerably greater abundance of a few species) is reflected in the total population figures as well as in the species/habitat saturation histograms (Figure 38). (The fact that Habitat "B" is highly suitable for 3 species for which Habitat "A" was marginal is reflected in the difference in C.I.N. values.) Some other cases, however, are less clear cut.

A comparison of the population numbers for the Bitumount aspen plot (total population 452 territories per 100 ha, C.I.N. of 11) with those for the Mature black spruce plot (203 and 11) suggests that, while the two habitats are suitable for the same number of species, the Bitumount aspen plot is more suitable because it supports more than double the total population. However, a glance at the species habitat saturation histograms for these two plots (Figures 8 and 13) reveals that they are in fact very similar in

Bird Species	Abbreviation	Maximum Density	Population / Habitat "A"	Population / Habitat "B"
Northern Three-toed Woodpecker	N3T	(6)	3 (50%)	5 (83%)
Hairy Woodpecker	HWP	(8)	3 (38%)	5 (63%)
Common Flicker	CFLK	(12)	5 (42%)	6 (50%)
Yellow-bellied Sapsucker	YBSS	(30)	8 (27%)	9 (30%)
Black-capped Chickadee	BCC	(12)	3 (25%)	4 (33%)
Grey Jay	GJ	(12)	4 (33%)	5 (42%)
Swainson's Thrush	SWT	(52)	15 (29%)	20 (38%)
Least Flycatcher	LFL	(195)	10 (5%)	100 (51%)
Red-eyed Vireo	REV	(126)	10 (8%)	11 (9%)
Tennessee Warbler	TEN	(112)	25 (22%)	100 (89%)
Yellow-rumped Warbler	YR	(80)	20 (25%)	21 (26%)
Ovenbird	OV	(138)	10 (7%)	100 (72%)
Western Tanager	WTAN	(23)	8 (35%)	9 (39%)
Dark-eyed Junco	DEJ	(112)	15 (13%)	16 (14%)
Chipping Sparrow	CH	(75)	20 (27%)	21 (28%)
		Total Population	159	432
		Species Richness	15	15
		C.I.N.	10	13
		Shannon-Weaver Index (B.S.D.)	2.51	2.09

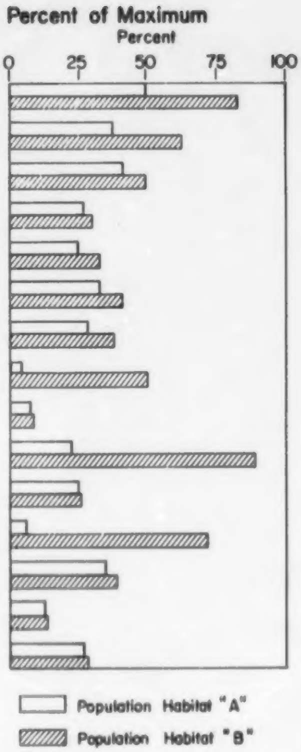


Figure 37. Derivation of species/habitat saturation histograms from raw population data.

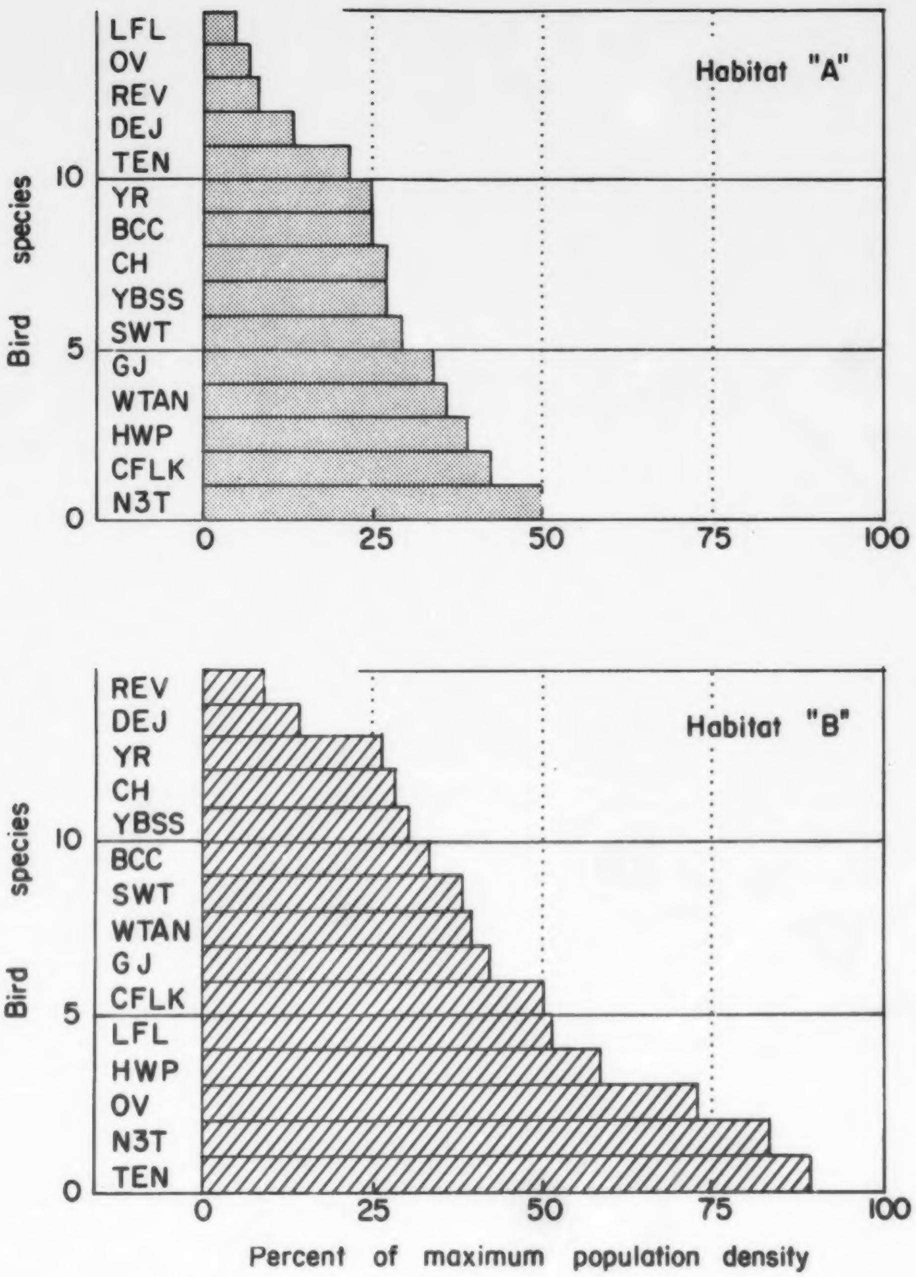


Figure 38. Species/habitat saturation histograms derived from data presented in Figure 37.

this respect. The difference is a function of the black spruce forest being suitable mainly to species which habitually breed at low population densities.

Thus, while total population figures for the two habitats are quite different, the habitats are of similar value with respect to "the number of species for which a habitat is suitable" and "the degree of suitability for those species".

8.15.3 Practical Limitations of the Maximum Density Concept

The maximum density concept is a valuable tool; it permits consideration of each individual bird species in the context of its own breeding biology. A table of maximum densities allows the assimilation of raw population data into numerical (C.I.N.) and graphic (species/habitat saturation histograms) forms which are both meaningful and easily comprehensible. In practice, however, the concept is not without problems.

The maximum density concept may be of limited applicability for certain bird species. Erskine (1974b) has questioned the validity of calculating population densities for many species thus, for these species, the concept of a maximum population density is also questionable. Several species, including the carduelline finches, either breed opportunistically, or are semi-colonial or both. Other species, most notably ducks and raptors, may utilize a variety of habitats, and may defend only a relatively small area around the nest site. Densities of these species, therefore, can be rather misleading. This problem was largely obviated in this study; these species were only counted in the population data when it was apparent that all aspects of their breeding requirements (i.e., mating, nesting, feeding and brood-raising) were satisfied within the habitat sampled by the study plot.

Knowledge of bird populations in boreal Canada is not, at this point in time, adequate to produce a perfect table of maxima. It is reasonably certain that the preferred habitat of many species has never been censused. Thus, many of the maxima in

Table 5 may eventually be exceeded. It is also possible that some species may, under unusual conditions, attain abnormally high densities, either briefly or locally. A more meaningful table would result if each species' maximum were calculated as an average from several years of replications of one plot in that species' preferred habitat, or an average of several different plots in that species' preferred habitat. However, this is patently impossible - the data simply do not exist.

7.15.4 The Shannon-Weaver Function (B.S.D. Index)

The decision not to use the B.S.D. index (the Shannon-Weaver function) in this study represents somewhat of a break with tradition. Therefore, a summary of the limitations of this index seems in order.

The Shannon-Weaver function weights two variables in any population: species richness and numerical equability. Thus it does not respond to proportional increases in population densities of all species (Table 61).

The Shannon-Weaver function is also strongly affected by population fluctuations and the presence of species occupying marginal or incidental niches. This is illustrated in Table 60. Figure 37 demonstrates that a habitat which is at least marginally better for all species present can be rated lower than another habitat (because the "less valuable" habitat has more equable numbers).

There appears to be no biological justification for rating habitats suitable only to species which habitually breed at similar densities higher than habitats equally suitable for low and high density species. Accordingly, interpretive techniques were designed for this study which consider each species in terms of its own breeding biology.

7.16 A HABITAT EVALUATION KEY FOR THE OIL SANDS AREA

The purpose of this key is to enable the evaluation of bird habitats without costly and time-consuming ornithological study. It is hoped that the key will be useful in locating roads,

Table 61. Shannon-Weaver function values for two hypothetical populations.

	Pop'n Density Set I	Pop'n Density Set II
Species A	1	100
Species B	1	100
Species C	1	100
Species D	1	100
Species E	1	100
Species F	1	100
Shannon-Weaver Function	1.79	1.79

townsites, and other developments away from the most valuable bird habitats. Conversely, it is hoped that some of the more valuable bird habitats can be incorporated into parks.

The parameters utilized in this evaluation key are those deduced in the discussion section of this report. The values assigned to specific variations were adjusted until a satisfactory evaluation was achieved for the eighty-four plot and subplot variations encountered in this study.

This key evaluates habitats according to the diversity and abundance of avifauna they are likely to support. Diversity is weighted more heavily than abundance.

Values of less than 9 signify poor habitat; 9 to 13 is the average range. Values 13 to 20 signify very good habitat; and ratings of more than 20 will occur only in exceptionally good habitats.

Sensitive or critical habitats are not specially weighted. Water-saturated habitats (muskegs and fens) appear to be most likely to sustain serious permanent impact. There may also be a shortage of overmature forests for several hundred years, and of mature coniferous forests for a somewhat shorter period.

One habitat component, balsam fir, is not dealt with in this key. Balsam fir was absent from our study plots, hence we were unable to establish its value. Erskine (1977:23) says of balsam fir: "Nearly all of the species listed as characteristic of the spruce forests are also regular in fir stands, the exceptions... Spruce Grouse and Canada Jay... are seemingly replaced by Ruffed Grouse and Blue Jay. Densities are roughly parallel in both spruce and fir stands for other bird species regular in both, but a number of species not often found in pure spruce are characteristic of fir stands..." Thus the use of this key to evaluate habitats in which balsam fir is a significant component may result in an underestimation of the value of those habitats. Balsam fir is rare in the central and northern portions of the study area, but becomes somewhat commoner south of Fort McMurray.

7.16.1 How to Use the Habitat Evaluation Key

This key should be applied not in terms of one vertical line, but rather in terms of an area at least 30 m in diameter. For each habitat, several such "readings" should be taken and averaged to establish the overall habitat value.

The habitat evaluation key is divided into three parts: ground cover only habitats, shrub and forest habitats, and interface evaluation. Habitat should be evaluated in terms of either Parts I and III, or Parts II and III.

The interface part should be applied only when an interface is present within 100 m. Most sections involve more than one choice; if the choices are lettered (i.e., a, b, c, etc.) only one should be chosen; if the choices are not lettered all should be applied.

7.16.1.1 Glossary for Habitat Evaluation Key

Ground cover - Woody stemmed plants less than 0.5 m tall plus all herbaceous plants. Does not include mosses and lichens.

Closed - Plant canopies touching or overlapping.

Dense - Plant canopies not touching or overlapping but separated by spaces of less than canopy diameters of individual plants.

Open - Plant canopies separated by spaces of one to two times canopy diameters of individual plants.

Scattered - Two to six times diameters.

Very scattered - More than six times diameters

Horizontal foliage/space diversity: openings of at least 2 m horizontally separate clumps of dense foliage.

7.16.2 Habitat Evaluation Key

Habitat entirely herbaceous, or woody-stemmed plants, if present, are predominantly less than 0.5 m tall.

Complete Parts I and III

Habitat includes at least scattered woody-stemmed plants taller than 0.5 m

Complete Parts II and III

Part I - GROUND COVER - ONLY HABITAT

1. Ground cover: (a) less than 0.5 m tall (+3)
   (b) 0.5 to 1 m tall (+4)
   (c) taller than 1 m (+5)
2. Very scattered woody stemmed plants taller than 1 m. (+1)
3. (a) Dead spars or clumps or dead bushes at least 10 per ha. (+1)
   (b) Flooded dead bushes abundant (+2)

TO PART III - INTERFACES

PART II - SHRUB AND FOREST HABITATS

1. Ground cover stratum:
   (a) Scattered - includes lichen/scattered heath (+1)
   (b) Open (+2)
   (c) dense, closed or varying open to closed (+3)
   (d) dominated by mosses (+3)
2. Herbaceous plants commonly taller than 30 cm (+1)
3. Foliage height diversity: Deciduous foliage if present.

Ground to 3 m:	Open or denser foliage	(0.5 per vertical m)
	Scattered foliage	(0.25 per vertical m)
3 to 7 m:	Open or denser foliage	(0.75 per vertical m)
	Scattered foliage	(0.5 per vertical m)
Above 7 m:	Scattered or denser foliage	(0.25 per vertical m)

   Very scattered deciduous foliage in a coniferous habitat: (0.25 per vertical m to a maximum of 1)
4. Foliage height diversity: Coniferous foliage if present.
   Scattered or denser foliage (0.25 per vertical m)
   Very scattered coniferous foliage in a deciduous habitat (0.25 per vertical metre to a maximum of 1)

5. Foliage density above 3 m.

   Foliage on shrubs or trees taller than 5 m forms open or denser cover between 3 and 7 m (+1)

   Foliage on trees taller than 9 m forms open or denser cover above 7 m (+1)

6. Foliage density 0.5 to 3 m.

   (a) Open or denser coniferous foliage (+1)

   (b) Habitat less than 7 m tall, open or denser layer of deciduous or mixed foliage between 0.5 and 3 m (+2)

   (c) Habitat more than 7 m tall; shrubs or trees predominantly taller than 1 m form open or denser layer between 0.5 and 3 m (+2)

   (d) Habitat more than 7 m tall; shrubs or trees predominantly less than 1 m tall form open or denser layer of foliage between 0.5 and 1 m (+1)

7. Horizontal foliage/space diversity, 1 to 7 m above ground.

   (a) Foliage scattered or absent above 7 m; horizontal foliage/space diversity in or above densest layer of foliage between 1 and 7 m above ground:

      Abundant through at least 3 vertical m, involving both deciduous and coniferous foliage (+3)

      Abundant through at least 3 vertical m, involving either deciduous or coniferous foliage (+2)

      Present through 3 vertical m or abundant through less than 3 vertical m (+1)

   (b) Foliage open or denser above 7 m horizontal foliage/space diversity abundant through at least 3 vertical m. (+1)

8. Horizontal foliage/space diversity in or above densest layer of foliage above 7 m:

(a) Abundant through at least 5 vertical metres, involving both deciduous and coniferous foliage (+3)

(b) Abundant through at least 5 vertical metres, involving either deciduous or coniferous foliage (+2)

(c) Present through at least 5 vertical metres, or abundant through 3 vertical m (+1)

9. Height diversity and horizontal foliage/space diversity in combination, provide abundance of exposed perches at all height levels within habitat (habitat being at least 3 m tall) (+1)

10. (a) Foliage 0.5 to 3 m; 3 to 7 m; or 0.5 to 7 m dominated by alder, rose, pine or swamp birch, either singly or in combination. Deduct 25% of value of appropriate stratum.

(b) Foliage 3 to 7 m dominated by willow. Add 25% to value of deciduous foliage 3 to 7 m.

11. Foliage above 7 m dominated by alder or pine. Deduct 25% of value of foliage above 7 m.

12. Habitat (a) Contains mature pine or tamarack, or scattered mature spruce (+1)

Contains overmature deciduous trees (+1)

(b) Contains stunted mature conifers (+1)

Is dominated by tall, mature spruce (+2)

(c) Contains overmature deciduous and coniferous trees (+4)

13. Habitat contains standing dead spars or stubs at least 4 m tall and at least 20 cm diameter at breast height (d.b.h.).

(a) At least 10 per ha (+1)

(b) At least 25 per ha (+2)

14. Habitat less than 7 m tall with very scattered trees at least 5 m taller (+1)

15. Habitat less than 4 m tall with dead spars at least 5 m taller, at least 20 per ha. (+1)

TO PART III - INTERFACES

PART III - INTERFACES

1. (a) Water/land interface or interface between habitats of different heights present within 100 m - to 2

(b) No water/land interface or interface between habitats of different heights present within 100 m - end.

2. Water/land interfaces, water type.

River wider than 5 m, lake, marsh or oxbow slough (+2)

River narrower than 5 m (+1)

3. Water edge (between land habitat and open water).

Gently sloping shore at least 1 m wide (+1)

Band of willow, dead willow or cattails (+2)

Band of sedges or rushes (+1)

4. Water/land interfaces: Land habitat (deduct 25% if dominanted by alder or pine and alder)

(a) Coniferous habitat (+1)

(b) Deciduous or mixed habitat less than 2 m tall (+1)

(c) Deciduous or mixed habitat 2 to 7 m tall (+2)

(d) Deciduous or mixed habitat more than 7 m tall (+3)

5. Land interfaces: Simple interfaces

(a) Taller habitat coniferous (+1)

(b) Taller habitat deciduous or mixed; height difference in habitats:

1 to 7 m above ground: 0.5 per vertical metre difference

above 7 m : 0.1 per vertical metre difference

6. Ecotones: Treat height difference as for simple interfaces and add 50%.

7. In riparian habitats: High water channel along interface (+2)

8. Successional gradients

(a) Successional gradient includes one band which is at least 50 m deep: Consider this band as a habitat with an interface on each side.

(b) Successional gradient involves coniferous trees only:

Providing little horizontal foliage/space diversity or height diversity across gradient (+1)

Providing considerable horizontal foliage/space diversity or height diversity across gradient (+2)

(c) Successional gradient involves deciduous or deciduous and coniferous foliage:

Providing little horizontal foliage/space diversity or height diversity across gradient (+1)

Horizontal foliage/space diversity and height diversity significant but not abundant (+2)

Horizontal foliage/space diversity and height diversity abundant across gradient (+3)

9. For land interfaces, deduct 25% of interface value if taller habitat is mixed and dominated by pine and alder.

Habitat Values: Less than 9 - poor
9 - 13 - average - good habitat
13 to 20 - very good habitat
more than 20- exceptional habitat

8. AOSERP RESEARCH REPORTS

1.		AOSERP First Annual Report, 1975
2.	AF 4.1.1	Walleye and Goldeye Fisheries Investigations in the Peace-Athabasca Delta--1975
3.	HE 1.1.1	Structure of a Traditional Baseline Data System
4.	VE 2.2	A Preliminary Vegetation Survey of the Alberta Oil Sands Environmental Research Program Study Area
5.	HY 3.1	The Evaluation of Wastewaters from an Oil Sand Extraction Plant
6.		Housing for the North--The Stackwall System
7.	AF 3.1.1	A Synopsis of the Physical and Biological Limnology and Fisheries Programs within the Alberta Oil Sands Area
8.	AF 1.2.1	The Impact of Saline Waters upon Freshwater Biota (A Literature Review and Bibliography)
9.	ME 3.3	Preliminary Investigations into the Magnitude of Fog Occurrence and Associated Problems in the Oil Sands Area
10.	HE 2.1	Development of a Research Design Related to Archaeological Studies in the Athabasca Oil Sands Area
11.	AF 2.2.1	Life Cycles of Some Common Aquatic Insects of the Athabasca River, Alberta
12.	ME 1.7	Very High Resolution Meteorological Satellite Study of Oil Sands Weather: "A Feasibility Study"
13.	ME 2.3.1	Plume Dispersion Measurements from an Oil Sands Extraction Plant, March 1976
14.		
15.	ME 3.4	A Climatology of Low Level Air Trajectories in the Alberta Oil Sands Area
16.	ME 1.6	The Feasibility of a Weather Radar near Fort McMurray, Alberta
17.	AF 2.1.1	A Survey of Baseline Levels of Contaminants in Aquatic Biota of the AOSERP Study Area
18.	HY 1.1	Interim Compilation of Stream Gauging Data to December 1976 for the Alberta Oil Sands Environmental Research Program
19.	ME 4.1	Calculations of Annual Averaged Sulphur Dioxide Concentrations at Ground Level in the AOSERP Study Area
20.	HY 3.1.1	Characterization of Organic Constituents in Waters and Wastewaters of the Athabasca Oil Sands Mining Area
21.		AOSERP Second Annual Report, 1976-77
22.		Alberta Oil Sands Environmental Research Program Interim Report to 1978 covering the period April 1975 to November 1978
23.	AF 1.1.2	Acute Lethality of Mine Depressurization Water on Trout Perch and Rainbow Trout
24.	ME 1.5.2	Air System Winter Field Study in the AOSERP Study Area, February 1977.
25.	ME 3.5.1	Review of Pollutant Transformation Processes Relevant to the Alberta Oil Sands Area

26.	AF 4.5.1	Interim Report on an Intensive Study of the Fish Fauna of the Muskeg River Watershed of Northeastern Alberta
27.	ME 1.5.1	Meteorology and Air Quality Winter Field Study in the AOSERP Study Area, March 1976
28.	VE 2.1	Interim Report on a Soils Inventory in the Athabasca Oil Sands Area
29.	ME 2.2	An Inventory System for Atmospheric Emissions in the AOSERP Study Area
30.	ME 2.1	Ambient Air Quality in the AOSERP Study Area, 1977
31.	VE 2.3	Ecological Habitat Mapping of the AOSERP Study Area: Phase I
32.		AOSERP Third Annual Report, 1977-78
33.	TF 1.2	Relationships Between Habitats, Forages, and Carrying Capacity of Moose Range in northern Alberta. Part I: Moose Preferences for Habitat Strata and Forages.
34.	HY 2.4	Heavy Metals in Bottom Sediments of the Mainstem Athabasca River System in the AOSERP Study Area
35.	AF 4.9.1	The Effects of Sedimentation on the Aquatic Biota
36.	AF 4.8.1	Fall Fisheries Investigations in the Athabasca and Clearwater Rivers Upstream of Fort McMurray: Volume I
37.	HE 2.2.2	Community Studies: Fort McMurray, Anzac, Fort MacKay
38.	VE 7.1.1	Techniques for the Control of Small Mammals: A Review
39.	ME 1.0	The Climatology of the Alberta Oil Sands Environmental Research Program Study Area
40.	WS 3.3	Mixing Characteristics of the Athabasca River below Fort McMurray - Winter Conditions
41.	AF 3.5.1	Acute and Chronic Toxicity of Vanadium to Fish
42.	TF 1.1.4	Analysis of Fur Production Records for Registered Traplines in the AOSERP Study Area, 1970-75
43.	TF 6.1	A Socioeconomic Evaluation of the Recreational Fish and Wildlife Resources in Alberta, with Particular Reference to the AOSERP Study Area. Volume I: Summary and Conclusions
44.	VE 3.1	Interim Report on Symptomology and Threshold Levels of Air Pollutant Injury to Vegetation, 1975 to 1978
45.	VE 3.3	Interim Report on Physiology and Mechanisms of Air-Borne Pollutant Injury to Vegetation, 1975 to 1978
46.	VE 3.4	Interim Report on Ecological Benchmarking and Biomonitoring for Detection of Air-Borne Pollutant Effects on Vegetation and Soils, 1975 to 1978.
47.	TF 1.1.1	A Visibility Bias Model for Aerial Surveys for Moose on the AOSERP Study Area
48.	HG 1.1	Interim Report on a Hydrogeological Investigation of the Muskeg River Basin, Alberta
49.	WS 1.3.3	The Ecology of Macrobenthic Invertebrate Communities in Hartley Creek, Northeastern Alberta
50.	ME 3.6	Literature Review on Pollution Deposition Processes
51.	HY 1.3	Interim Compilation of 1976 Suspended Sediment Date in the AOSERP Study Area
52.	ME 2.3.2	Plume Dispersion Measurements from an Oil Sands Extraction Plan, June 1977

53.	HY 3.1.2	Baseline States of Organic Constituents in the Athabasca River System Upstream of Fort McMurray
54.	WS 2.3	A Preliminary Study of Chemical and Microbial Characteristics of the Athabasca River in the Athabasca Oil Sands Area of Northeastern Alberta
55.	HY 2.6	Microbial Populations in the Athabasca River
56.	AF 3.2.1	The Acute Toxicity of Saline Groundwater and of Vanadium to Fish and Aquatic Invertebrates
57.	LS 2.3.1	Ecological Habitat Mapping of the AOSERP Study Area (Supplement): Phase I
58.	AF 2.0.2	Interim Report on Ecological Studies on the Lower Trophic Levels of Muskeg Rivers Within the Alberta Oil Sands Environmental Research Program Study Area
59.	TF 3.1	Semi-Aquatic Mammals: Annotated Bibliography
60.	WS 1.1.1	Synthesis of Surface Water Hydrology
61.	AF 4.5.2	An Intensive Study of the Fish Fauna of the Steepbank River Watershed of Northeastern Alberta
62.	TF 5.1	Amphibians and Reptiles in the AOSERP Study Area
63.	ME 3.8.3	Analysis of AOSERP Plume Sigma Data
64.	LS 21.6.1	A Review of the Baseline Data Relevant to the Impacts of Oil Sands Development on Large Mammals in the AOSERP Study Area
65.	LS 21.6.2	A Review of the Baseline Data Relevant to the Impacts of Oil Sands Development on Black Bears in the AOSERP Study Area
66.	AS 4.3.2	An Assessment of the Models LIRAQ and ADPIC for Application to the Athabasca Oil Sands Area
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Alberta Oil Sands Environmental Research Program
15th Floor, Oxbridge Place
9820 - 106 Street
Edmonton, Alberta
T5K 2J6